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Vol. 6 No. 71 (New series) NOVEMBER, 1960

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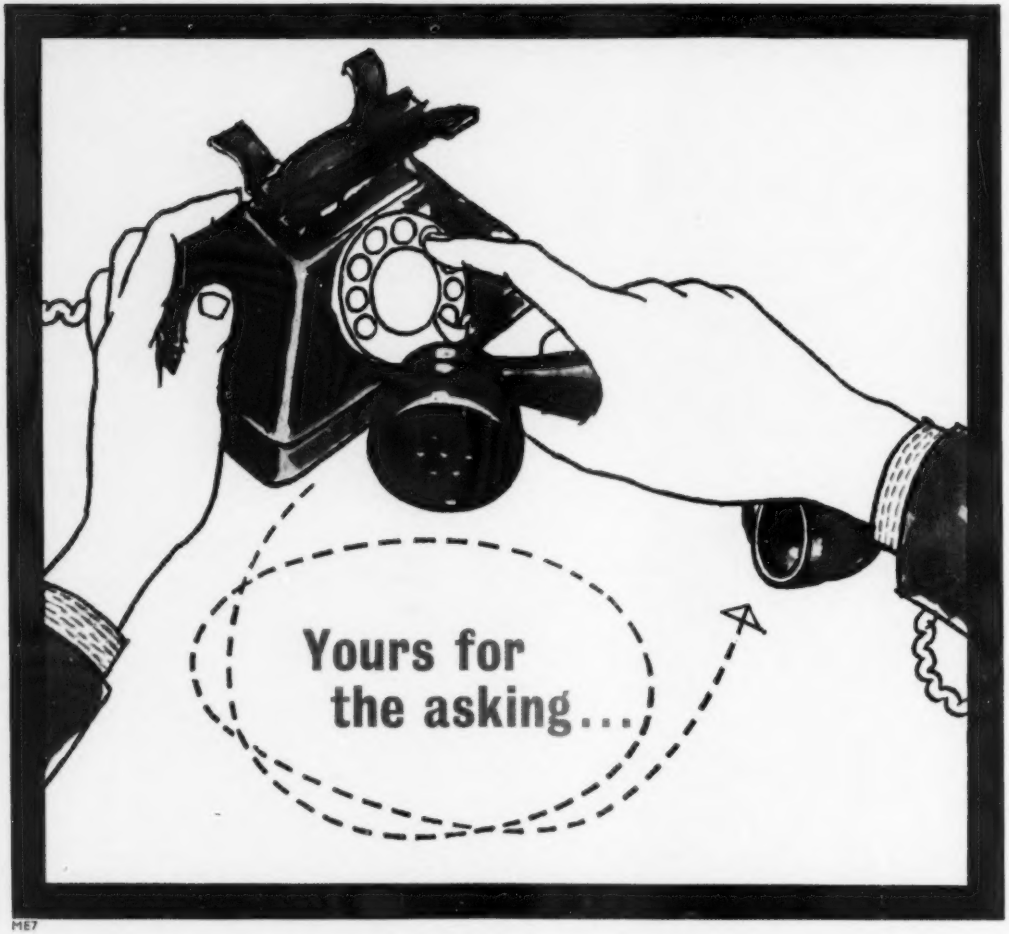

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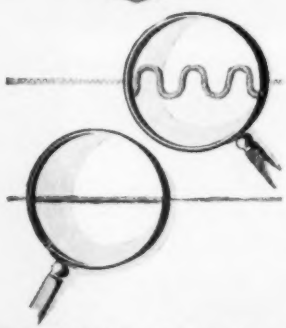

Magnified view of a cotton thread taken from " Tuff " material to show severe crimping.

Magnified view of a cotton thread.

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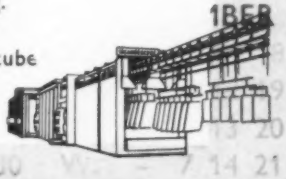

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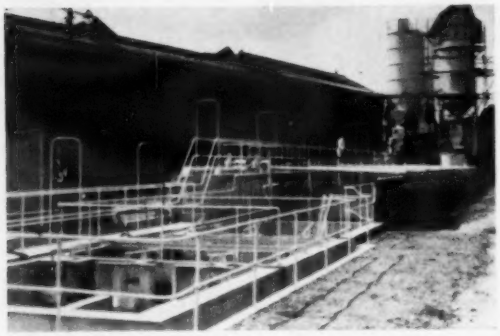

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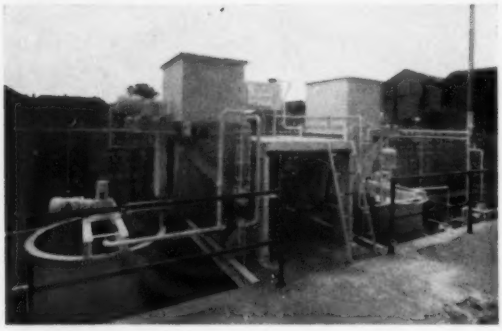

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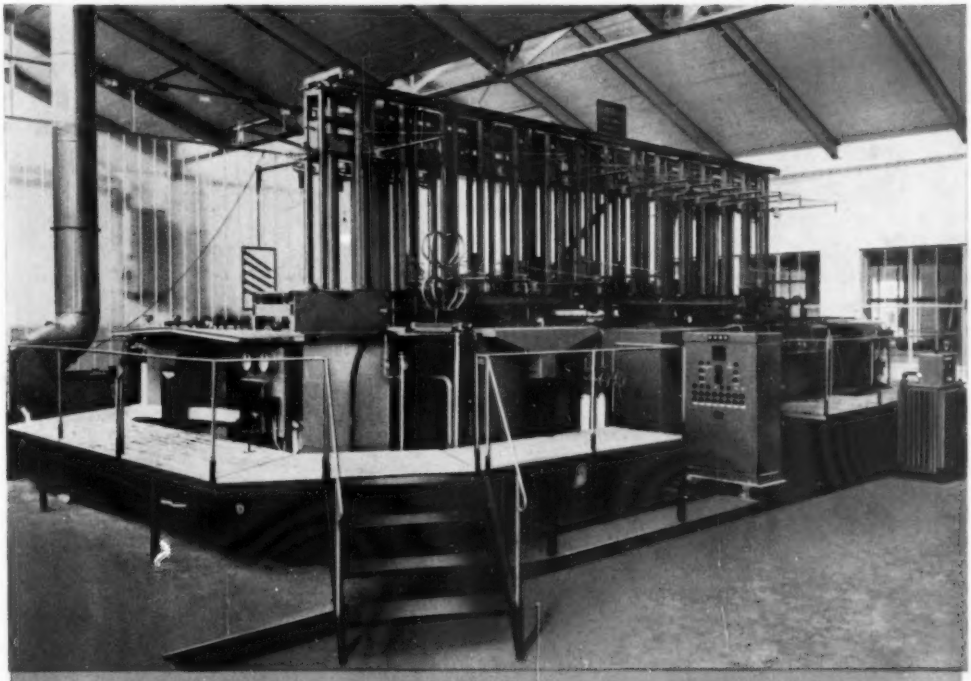

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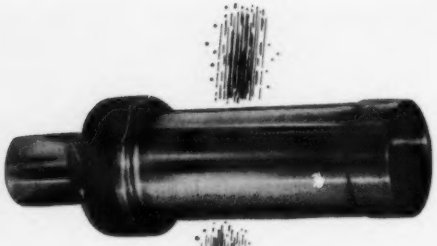

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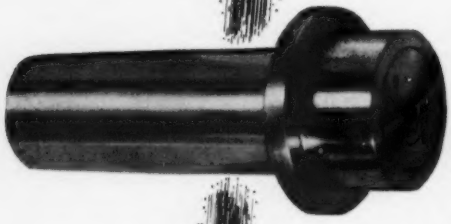

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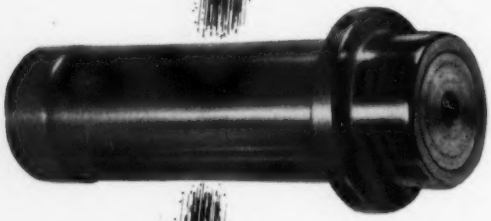

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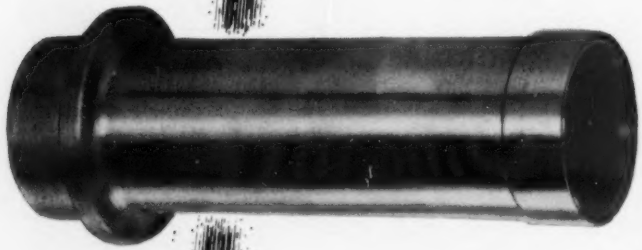

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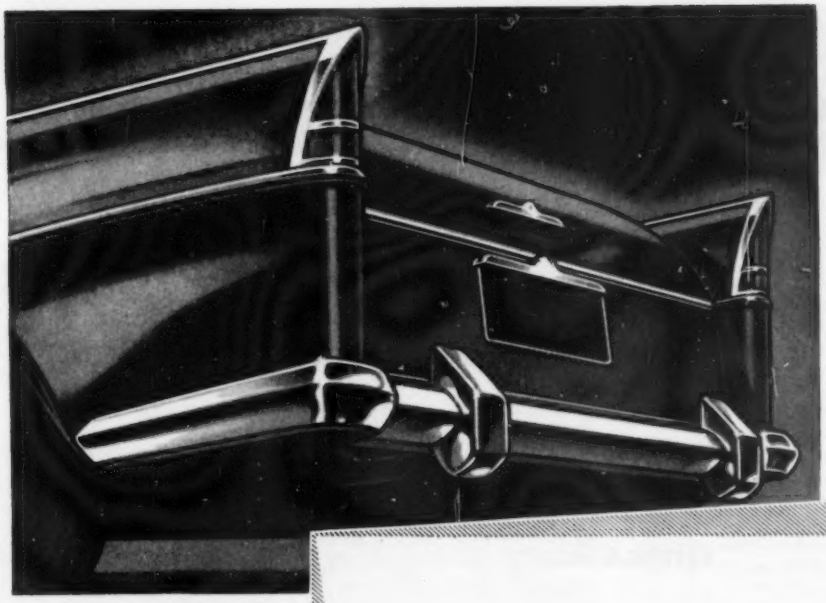

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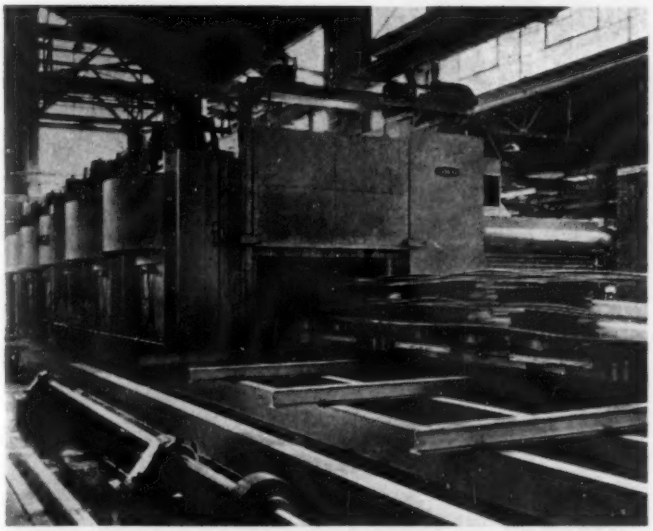

Accommodates slab lengths of 65 ft. x 6 ft. 6 ins.

In the recent large-scale development programme spread over some 30 months, the Northern Aluminium Co. Ltd. has introduced considerable quantities of new plant and handling equipment. A new batch-type furnace, designed and erected by G.W.B. at the Banbury Works of Northern Aluminium, was part of this programme. Production at Banbury, both in aluminium and a variety of aluminium alloys, embraces a wide range of sheets, discs and coils.

Owing to the occurrence of a certain amount of work-hardening (8 in. thick ingots of aluminium are hot rolled to a thickness of approximately 0.3 to 0.5 in.) it is necessary for slabs to be annealed prior to being cold rolled to lighter gauges. The rating of this G.W.B. furnace is 1,000 kW and it comprises six independent and automatically controlled zones of equal length. Rating distribution is as follows: Zone 1 220 kW, Zones 2-5 150 kW each, Zone 6 180 kW. *Owing to the high rating, cycle times as low as 4 hours are regularly obtained.* The maximum temperature of the furnace is 600°C, normal operating temperature being rather lower than this figure.

The heating chamber is lined throughout with heat-resisting alloy, backed by a thick wall of Moler insulating bricks, thus reducing heat losses to a minimum. The furnace casing is constructed from sheet mild steel braced with steel rolled sections and fitted with a mild steel front plate. A cast-framed, refractory faced, fully insulated and counter-balanced door, driven by electric motor, is sealed against the furnace face by pneumatic clamps, thus minimizing heat losses at the furnace entrance. The furnace is supported clear of the ground.

Nickel-chromium strip heating elements, arranged on removable plugs, are situated in the roof chamber, and each zone is fitted with a forced-air circulation system directed cross-flow from the fan, through the heating elements contained in the ducted portion of heating chamber, down into the treatment chamber, and back into the fan for re-circulation. Radiation on to the charge is prevented by a special baffle fitted in the roof chamber to separate the heating elements from the actual working area. Baffles, each independently adjustable and extending the full length of the chamber on each side, direct the air flow to give desired flow characteristics and equalise the temperature throughout the working chamber.

Six air circulating fans are fitted, one per zone. A cooling chamber, similar in size to the heating chamber is incorporated in the unit. A G.W.B. single track charging machine serves both the furnace and the cooling chamber.

As a result of the modernisation, the new rolling mills can roll aluminium sheet to a maximum width of 6 ft. 6 in.; the previous maximum had been 5 ft. The G.W.B. furnace naturally was designed to handle this increased width. It can accommodate loads up to 16 tons for slab lengths of 65 ft. The furnace is normally used to treat slabs of heavy-duty materials for varied employment: Aircraft, coachwork, decorative finishes, car trimming and a host of other uses.

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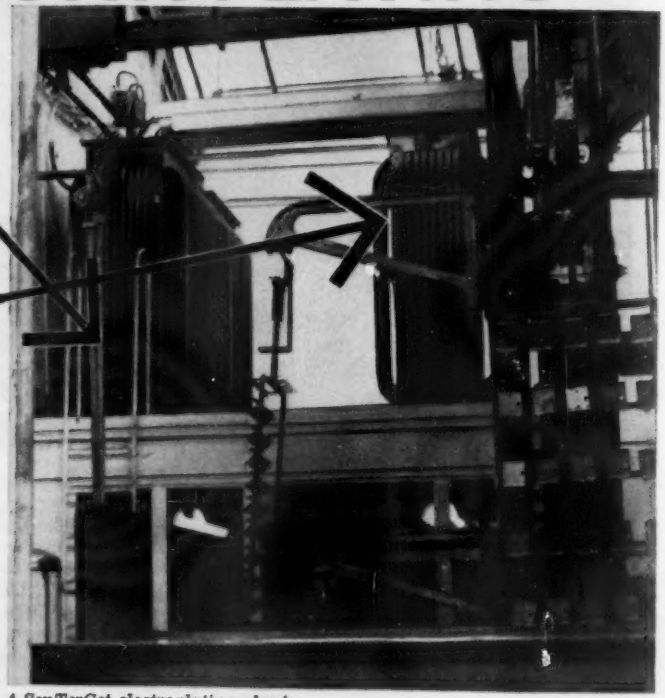

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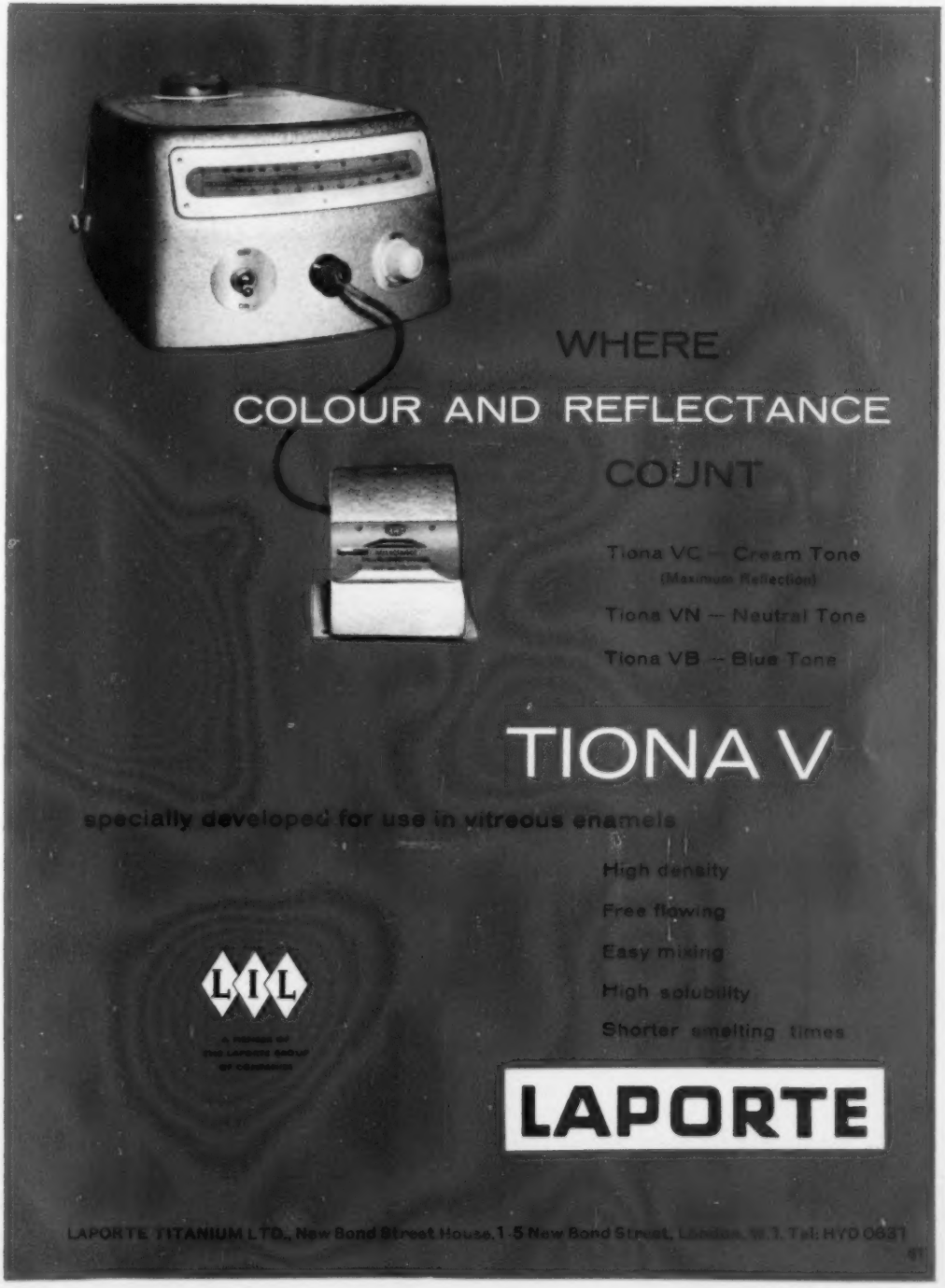
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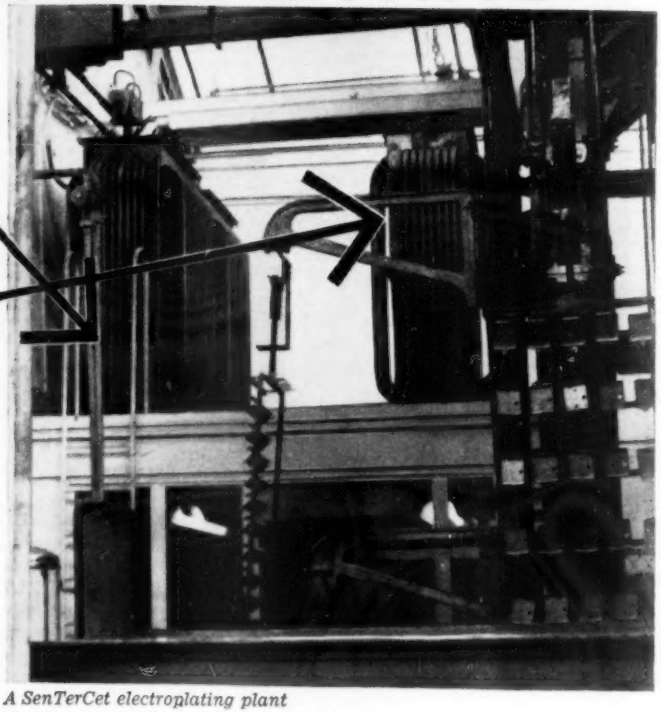

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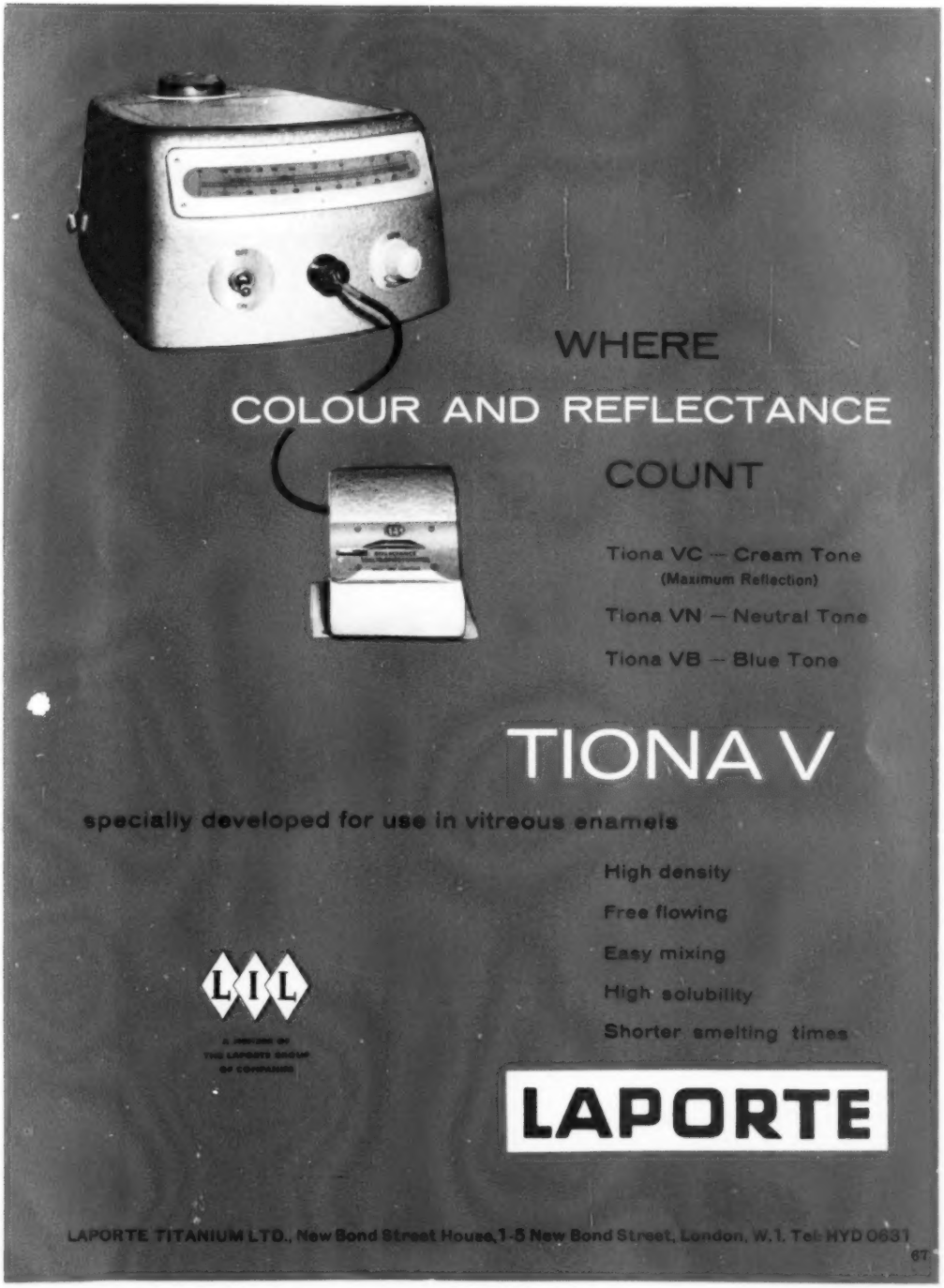
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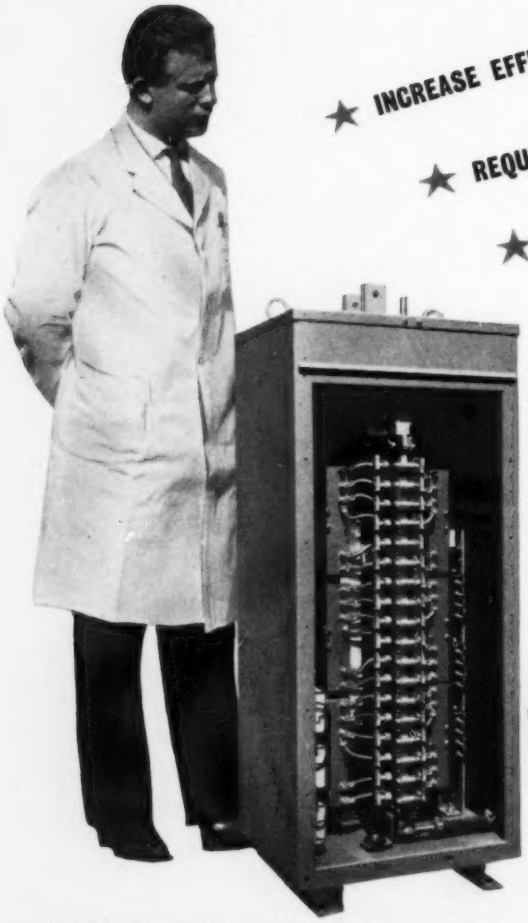

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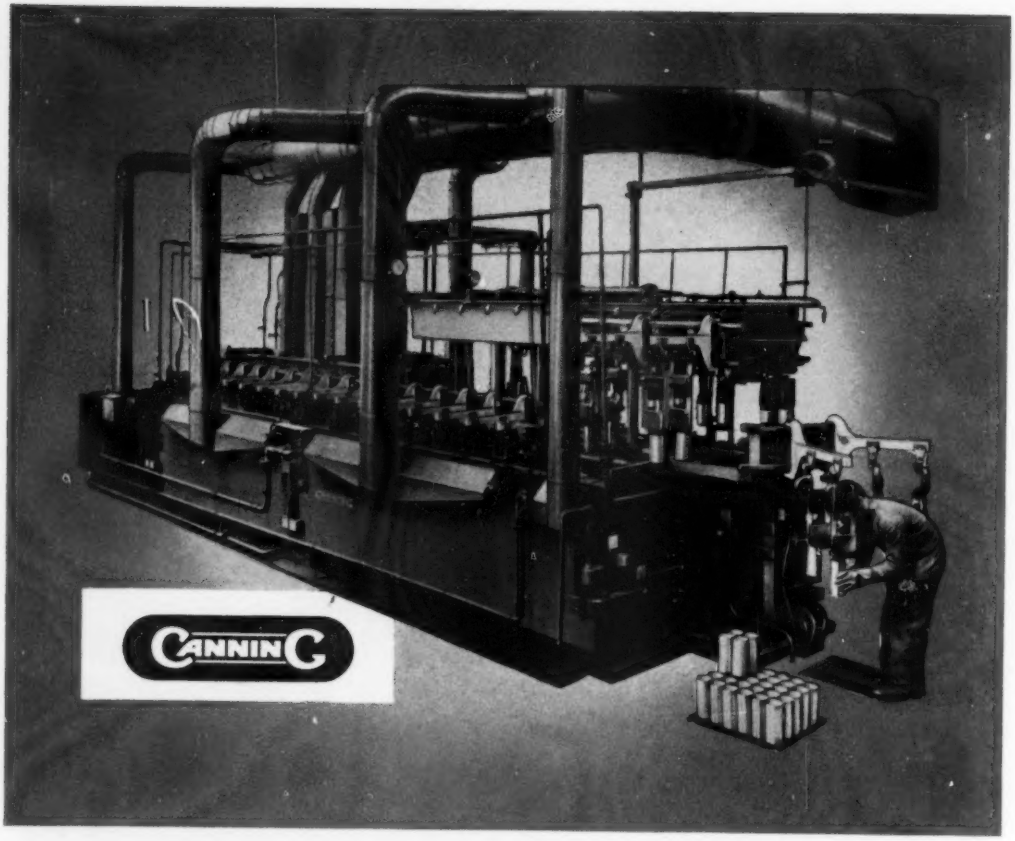

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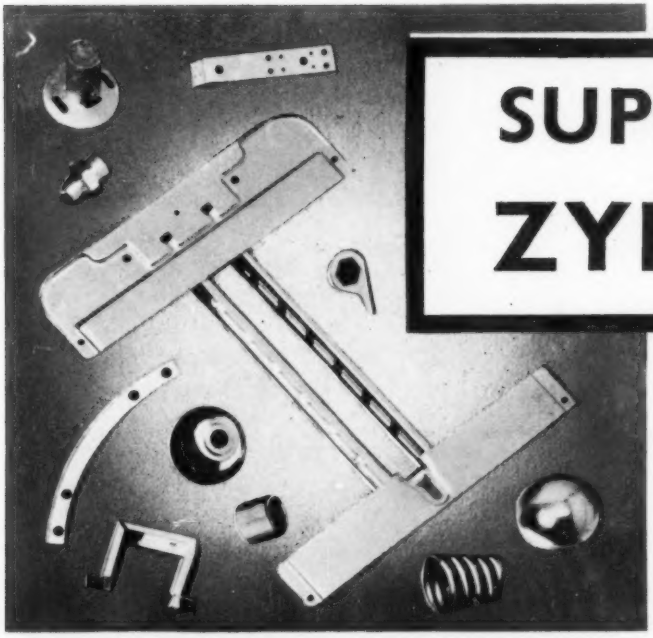

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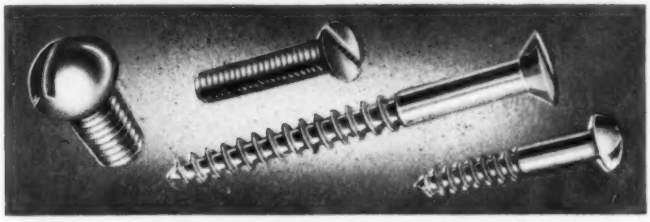

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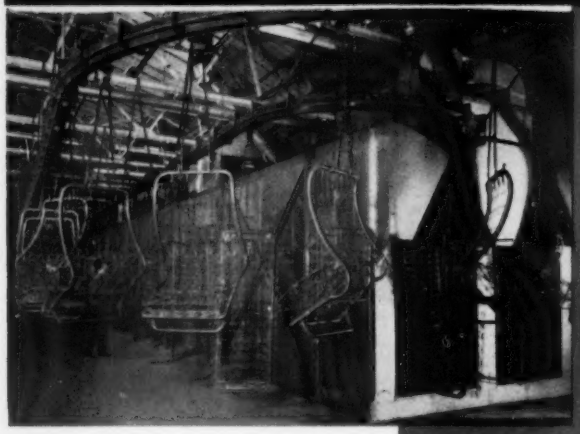

These three installations are excellent examples of Stordy engineering in the design and building of plant for the pretreatment, painting and stoving of metal parts.

Illustration above: A continuous conveyor oven, forming part of a complete painting and stoving installation for the production of multiplicity of car and similar seats.

Illustration right: A direct gas fired, air circulated camel-back conveyor stoving oven for metal building sections up to 40 feet wide × 7'6 deep.

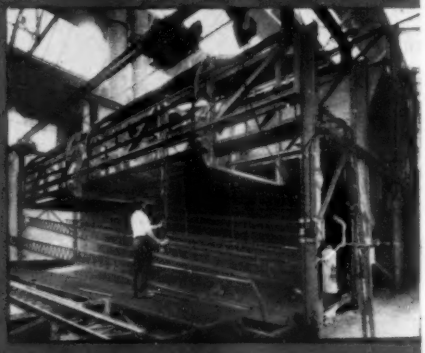

Illustration below: Six-stage cleaning and phosphating plant and dip painting equipment for motor panels. Complete installation includes paint dip and dump tanks, paint circulating and storage equipment, drain tunnel, etc.

STORDY ENGINEERING LIMITED
CUMBRIA HOUSE · GOLDTHORN HILL · WOLVERHAMPTON
S.H.S.E. 6127

metal finishing Journal

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INSTITUTE OF VITREOUS ENAMELLERS

President :
W. T. WREN

Chairman :
J. NICHOLLS

Secretary :
J. D. GARDOM
John Gardom & Co., Ripley, Derby
Telephone : Ripley 136

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F. H. Harley
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JOHN ADAM HOUSE
17-19 JOHN ADAM STREET
ADELPHI, LONDON, W.C.2
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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

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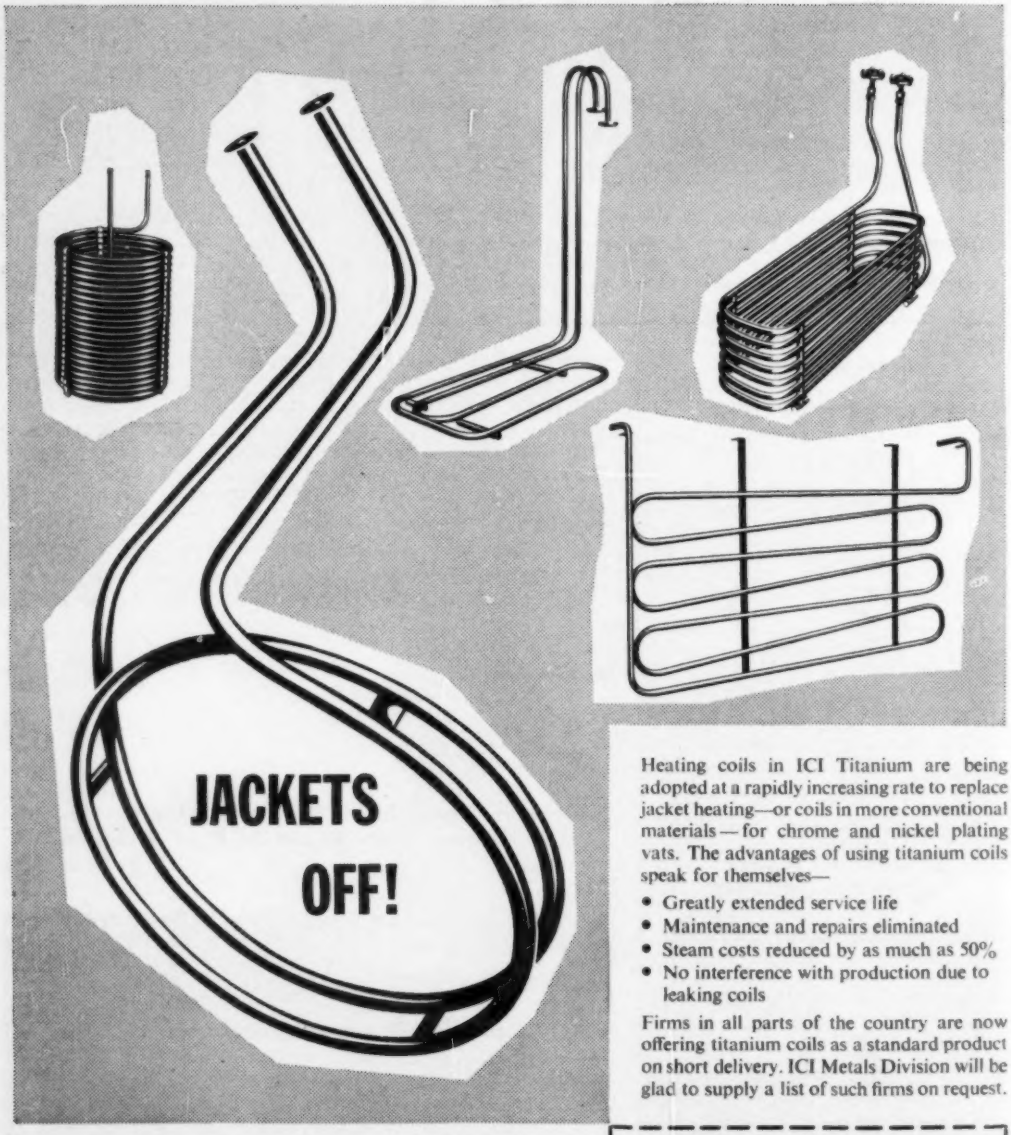

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A CASE FOR COMPROMISE

THE factors which determine whether a product is likely to be readily saleable, or alternatively a drag on the market, are obviously worthy of study, although in some respects certain of them are not particularly amenable to exact assessment. Such intangibles as the arbitrary dictates of fashion, which decree that it shall be appropriate to wear a frock modelled on an inverted potato sack rather than one conforming to widely accepted standards of elegance, are manifestly difficult to predict and can produce pit-falls for unwary investigators of potential markets.

Nevertheless, it is possible to list certain broad characteristics which are basically necessary to a product to enable it to compete effectively for sales. This list will include such attributes as functional efficiency, adequate service life, an economic price, and an attractive appearance in line with current fashionable trends.

Although these differing aspects of the qualities of a product are each capable of individual appraisal, they are, to a very great extent, interdependent, and any variation in the method of production introduced with a view to achieving a desired improvement in one direction may well have a profound effect, adverse or otherwise, in one or more of the others. Thus, an increase in service life might be achieved at the cost of functional efficiency or increase in price, while a modification for improving functional efficiency may react adversely on appearance.

It should therefore be apparent, that any product should be conceived as a whole and due weight given to every aspect of its design and production from the very beginning. There is available to the modern manufacturer a considerable range of materials and processes from which he can select those best suited and in many instances the choice is dictated by the need to compromise between the conflicting requirements of design and production. Such compromises if properly arrived at after due weighing of all appropriate considerations should not be regarded as improper, and the only source of danger in implementing them lies in the possibility that certain relevant factors were not properly considered.

It is becoming a common practice today to bring together a team whenever a new manufacturing project is under discussion, the members of that team being qualified to speak in a number of specialized fields, and here again the practice is an excellent one, provided that the team is selected with a proper balance, and due heed is paid to the views of each member; however, it is fair to question whether anyone competent to discuss matters relating to finishing ever had any say in the production planning of most products.

The requirements of the majority of modern finishing processes are not particularly exacting although they can reasonably be said to be specialized. But it is in the areas of design and material selection that they are most sensitive to adverse conditions.

Some years ago the Vitreous Enamellers Association published a brochure outlining the fundamental design requirements of articles intended for subsequent enamelling. This month has seen the publication by the Institute of Metal Finishing of a similar, though necessarily more extensive, booklet dealing with polishing, electroplating and painting insofar as these processes have special design requirements. It is to be hoped that this booklet and any other publications on the subject will be widely consulted whenever the design of a product requiring subsequent finishing is under consideration.

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

WANTED—CHEAPER TESTING

ONLY recently introduced, the thermo-electric plating thickness gauge developed by the BNFMRA has been rapidly followed by yet another plating thickness testing device, the Coulometric Meter from the same stable. In this instrument, the quantity of electricity, as measured on a current integrator, required to dissolve away a defined area of the plate establishes the coating thickness ; it is therefore not entirely non-destructive (unlike the thermo-electric gauge). It does, however, give an absolute thickness value, and can be used for calibrating instruments based on comparative readings.

The Coulometric Meter is claimed to have exceptionally great accuracy, the standard deviation being only 0.000013 in. at one-thousandth of an inch thickness, and therefore provides for the first time a method which can be used for the accurate control of chromium coatings.

There is now quite a range of instruments available for plating thickness determination of varying degrees of accuracy, and the problem can now be said to have been solved technically, at any rate.

The chief bugbear, however, is cost, as all the really good instruments are elaborate and expensive. A cheap plating thickness gauge that can be used on the shop floor and is within the means of every plater is still an unfulfilled want.

NO MORE BRUSHES?

EVER since prehistoric man daubed animals high on the walls of the caves of Lascaux, with a few hairs pulled off a wild boar's coat, the brush has been the standard method of applying paint. Whilst industrial finishers think of the spray gun as a very important device, the gallonage of paint applied by this method is still very small when it is compared with that put on by brush.

The brush, despite its limitations, is still a hard thing to improve upon, but a lot of thought has been given to alternative devices. The motive is apparently, that if something has been in use for thousands of years it must be ripe for a change. The paint roller is one of the most successful substitutes for the brush and is now used quite a bit ; the latest thing, however, is a pad type of paint applicator of American origin which consists of a flat plastic foam strip onto which is bonded a piece of mohair velvet. The whole is attached to a gold anodized aluminium handle. In use, the mohair surface is dipped into the paint, and is then used in a similar fashion to a brush. The main advantages seem to be a reduced tendency to drip and the ease with which it is possible to obtain well-defined edges to the paint work. On the whole, however, the selling point of the new device appears to be novelty, for which there is always a market. Of course, painting is still, to some extent, a craft, and craftsmen have a vested interest in discouraging the introduction of anything which makes their job more readily duplicated by the unskilled. It is for this reason that we are unlikely to see a professional house painter using either a roller or a pad—unless, possibly, in the privacy of his own home!

ALL ABOARD

IT won't be long now before the Spring Conference season opens and, as often as not, this means a meeting in a coastal town. But why stay on land? In the U.S.A. more and more conventions are taking to sea, the meetings being held on board while the ship cruises to the Bahamas or Bermuda. Last year it is reported that 80 conventions were held at sea ; this is a tiny proportion of the 75,000 U.S. conventions held each year, but the Swedish American Line has such a confidence in the future of the convention cruise that it is planning to build a ship especially designed for the purpose.

Amongst the advantages claimed for a nautical conference are the fact that the delegates cannot get away so that meetings are better attended (weather permitting, of course), and that the cruise is tax free. Moreover, corrosion tests could be conveniently carried out meantime!

NEW INVENTION

THE research department of a large oil company announces that it has developed a quick, simple and inexpensive test for checking the completeness of the removal of mill scale from steel plate. Further reading elicits the fact that the new method is only our old friend the copper sulphate test, whereby copper is chemically deposited on the clean steel but not on the scale particles.

Apart from its lack of novelty, the question potential users should ask themselves is what is to become of the copper and the iron sulphate left on the steel after the test as a result of the reaction. It is hardly the best basis for painting onto.

INSTITUTE of VITREOUS ENAMELLERS

Annual Conference, Birmingham, 1960

A Report of the First Technical Session

A METHOD OF MEASURING THE ABRASION RESISTANCE OF VITREOUS ENAMELS

A Report of an Institute of Vitreous Enamellers' Sub-Committee. The Sub-Committee was composed of: Dr. B. K. Niklewski; Mr. W. E. Benton; Mr. W. E. Charles; Mr. N. S. C. Millar; with Mr. R. H. Ashby as a co-opted member.

Introduction

THE object of the Sub-Committee was to devise a reliable method of testing the abrasion resistance of vitreous enamel that gave reproducible results and that would differentiate between different enamels.

The following methods of testing the abrasion resistance that have been used in the enamelling industry were considered.

1. *The Diamond Scratch Test*

This method, in which a loaded diamond point is drawn over the surface, will differentiate very well between different enamel surfaces but is unreliable because of possible variations between different diamond points.

2. *The Abrasion Resistance Test, as described in B.S.S.* 1344: 1947.

This method consists of scratching the surface of the enamel by means of powders of specified fineness, corresponding in hardness to Moh's Scale. A small amount of powder is sprinkled on to the enamel surface, covering approximately ¼ square inch of the surface, covered with chamois leather and loaded by a 2-lb. weight of specified dimensions. The leather and weight is then drawn to and fro over ½ in. travel of the surface 10 or 12 times. The criterion of failure is visible scratches caused by powder of hardness 6 (Felspar) or lower, when viewed through a pocket microscope of magnification x 8. This method was considered unsuitable because it does not differentiate enough between enamels.

3. *The Taber Abraser*

This test consists of a mechanical method in which the sample plate is rotated in contact with abrasive wheels under a predetermined load. The method of estimation is by loss of gloss or loss of weight after a stated number of revolutions. The results obtained with this machine are consistent. The method was considered to be unsuitable because the machine is expensive and of foreign origin. The abrasive wheels deteriorate with age and must be replaced after one year.

4. *A Standard Method of Abrasion Measurement introduced by the Porcelain Enamel Institute of America*

This method is substantially the same as the method adopted by the Sub-Committee and described below. The machine now used in the P.E.I. test consists of a moving table which describes an eccentric circle so that the brading charge on the sample plate moves in a circle of 1 in. diameter. The criterion of wear is the total loss of weight or loss of gloss, after a specified time of abrasion.

Method of Test Adopted

The machine agreed upon by the Committee to be tested for reliability was built by Gallenkamp and Co. Ltd. This comprises, essentially, a table to which the sample plate is clamped that moves with a to-and-fro motion. The clamping device is so constructed to contain the abrading charge of a specified weight of sand, steel balls and water. The table is driven by an electric motor, *via* an eccentric pin and lever mechanism at the rate of 300 + 3, −0 r.p.m.

Reproducibility of Results

Nine samples of a standard titania-opacified white enamel were prepared at the same time, under conditions as nearly as possible the same. The abrading charge used was :

175 gm. stainless-steel balls of 5/32 in. diameter.
3 gm. sand, graded between 72 and 100 mesh B.S.S. Sieves.
20 ml. distilled water.

The loss in weight of the samples was measured after 5, 10, 20 and 30 minutes of abrasion. The machine was re-charged with sand and water every 5 minutes, the old abrading charge being washed away. The results are summarized in Table I.

The loss in weight of the samples up to 15 minutes of abrasion is very low. The loss of weight after 5 minutes abrasion is so small that the percentage deviation is very high. This is because some of the weight differences are within the weighing error of the balance. These figures should be ignored. Control of weighing conditions should be as fine as possible. The test plate should be dried thoroughly preferably by heating to 110°C. and cooling to weighing room temperature in a desiccator. Preparation of test-pieces is therefore critical. This should be so carried out that chipping during the test is eliminated completely. For test-pieces cut from panels that cannot be accommodated on the machine, some method of sealing the cut edges must be adopted.

Table I

Sample	Cumulative weight loss, mg.			
	5 min.	10 min.	20 min.	30 min.
1	1.2	4.7	17.3	36.6
2	1.4	4.5	18.8	39.5
3	0.7	4.2	18.2	38.7
4	1.2	4.1	14.5	33.7
5	1.5	3.4	15.1	33.5
6	1.3	3.7	15.2	34.2
7	0.8	4.0	15.2	32.2
8	1.4	3.8	15.4	34.3
9	—	4.0	16.2	36.5
Mean	1.2	4.04	16.2	36.4
Mean deviation	0.22	0.3	1.3	2.0
Mean deviation as percentage	18.3	7.2	8.0	5.7

Table II

Sample	Cumulative weight loss, mg.			Enamel type
	10 min.	20 min.	30 min.	
B.1	2.3	10.2	24.0	Titania-type blue cover coat.
W.1	10.8	36.3	66.4	Antimony white cover coat.
R.1	9.1	29.9	54.6	A.R. Clear red cover coat.

The result in Table I show the required consistency for the method and the apparatus to be used for tests. A further three panels were tested to check the results obtained with different enamels. These results, summarized in Table II, show that the method will distinguish between different enamels with sufficient preciseness.

Reproducibility of the Machine

Three machines were ordered and tested together with the original machine. For this trial the abrading charge used was :

175 gm. stainless-steel balls.
3 gm. graded sand.
25 ml. distilled water.

The test plates were weighed after 10, 15 and 20 min. of abrasion. The abrading charge was replaced every 5 minutes. The results are summarized in Table III.

Table III

Machine	Sample	Cumulative weight loss, mg.		
		10 min.	15 min.	20 min.
1	1	2.7	5.9	13.9
	2	3.8	9.3	15.6
	3	3.9	7.9	15.4
2	1	2.9	6.8	12.6
	2	3.8	9.8	15.7
	3	3.8	8.4	15.1
3	1	3.1	7.4	13.0
	2	3.6	8.3	14.6
	3	3.8	8.6	14.8
4	1	3.2	8.0	13.6
	2	3.5	7.4	13.5
	3	3.8	8.5	14.6
Mean		3.5	8.3	14.4
Mean deviation		0.34	0.71	0.87
Mean deviation as percentage		9.7	8.5	6.0

Sample No. 2 on machine No. 2, could have lost weight by accidental chipping. As the divergence of results on machines 1 and 2 appeared to be high, a further four samples, one on each machine, were tested. These are numbered 3 in the above table.

These results indicate that the machines are consistent enough to be used as standard test machines. The machines must be securely fixed during test. A series of tests were run with the machines free standing. The results obtained with each machine were consistent, but varied considerably between the separate machines.

Comparison of Abrasion Obtained using Different Sands

Another series of tests was carried out, using

Machine No. 4, to determine whether the source of sand had any influence on the results. These tests are summarized in Table IV.

Table IV

Sand Source	Test	Loss of weight, mg.		
		10 min.	15 min.	20 min.
Leighton Buzzard	1	1.0	1.9	3.8
Congleton	1	0.7	1.6	2.0
	2	0.2	0.9	1.0
Southport Sea Sand	1	0.7	1.5	2.3
	2	0.7	1.5	2.5
Chelford	1	0.9	1.0	1.9
	2	0.6	1.5	2.0
Redhill Glass Sand	1	3.5	7.6	12.6
	2	3.3	7.4	13.8
Core Sand	1	2.1	5.4	10.0
	2	2.9	6.2	11.8
	3	2.4	5.6	10.1

These results indicate without doubt that the source of the abrading sand is critical. The majority of these sands are described as sub-angular in type, so that sands of the same type do not have the same effect when used as above. The different samples of Redhill sand tested show that chemical treatment has no effect on the sands' abrasive characteristics.

The committee decided to specify Redhill sand as the standard abrading medium.

Procedure

The 4-in. x 4-in. test plate is cleaned and dried. This may be done by wiping with alcohol or ether using a non-fluffy material to remove any grease or dust and drying in an oven at 110°C. When the plate has attained the temperature of the weighing room, preferably in a desiccator, it is weighed as accurately as possible to the nearest 0.1 mg. The same procedure to be used for drying before each weighing during the test.

After weighing, the test plate is placed on the machine, the sealing ring and clamp ring located on it, and the abrading charge loaded on to it. This comprises :

175 gm. stainless-steel balls of 5/32 in. diameter.
3 gm. Redhill sand passing through 72 mesh sieve, remaining on 100 mesh sieve. The sieves are of B.S.S. 410.

The clamp plate is placed over the clamp ring and tightened to form a water-tight seal. 25 ml. of distilled water are then added through the hole in the clamp plate.

At five-minute intervals, the machine is stopped, the old abrading charge is washed away, the steel balls washed and dried and a new abrading charge added.

The loss of weight of the test plate is measured for as long as is required to obtain a graph of the relation between loss of weight and time of abrasion.

For most enamels, the loss of weight for the first five minutes of abrasion will not be significant. It is suggested that weighing to be commenced after 10 minutes of abrasion. Most enamels will show significant losses in weight after 30 minutes of test.

DISCUSSION

MR. S. E. A. RYDER commenting on the very careful work which had been done by the Sub-Committee said that the machine appeared to be within the poor financial resources of the vitreous enamellers.

Speaking of the report, he said that before it became an Institute standard, he would like to see some alteration in the method of weighing the samples. Also he would like some practical details concerning the method of handling the sample plates in the air after they had been dried in an oven at 110°C. to be incorporated. The samples should be handled carefully, not with the fingers, and regard must be paid to humidity ; obviously this was most important, for the weighing was to be done to the nearest 0.1 mg.

He asked how much difference there would be in the time required to obtain the results if the charges were not changed at five-minute intervals ; and whether the time of the standard tests could be altered so that a better comparison between the various samples could be obtained. Mr. Ryder also asked how the used abrading charge was removed without making a horrible mess all over the top of the machine and, whether any change took place in the sand during the period of abrasion.

DR. NIKLEWSKI said that the sample plates must be completely dry. A desiccator should always be used and the weighing should be done by someone who was used to operating a delicate balance.

The Sub-Committee had not specified any particular method of removing the abrading charge and they preferred that users of the machine should decide that for themselves. The water could be soaked out by means of paper, for instance ; the method used would not affect the accuracy of the results obtained from the machine.

The sand in the abrasive charge did not break down. The fine particles did not abrade ; indeed, they put a brake on abrasion. Some kind of suspension might form however, and that was why the Sub-Committee insisted on exact measurements in making up the charges.

As to the alteration of the time over which the sample plates were abraded, he said the abrasion curves were at first very flat, then they turned upwards rather steeply and became linear ; there was no point in continuing the abrasion after 20

or 30 minutes because the curves then remained linear.

The first two of the newly devised machines were freestanding, and in operation they "walked" slowly along the bench on which they were mounted, due to the to-and-fro motion of the table to which the sample was clamped. Plates had now been fixed to the bottom of the machine to prevent that "walking." Movement of the machine influenced the determinations, because part of the energy applied would be devoted to that movement.

Views of The Gas Industry

MR. E. W. B. DUNNING said the testing and approving of appliances from the point of view of the gas industry was quite different from the enamellers' research and development work; harder enamels were involved. The original Moh's hardness test was developed in the gas industry's laboratories many years before the war; however, the industry was quite ready to adopt some new method if it proved to be better.

The gas industry was not prepared to accept a sample plate as being the same as the enamel on a gas cooker; indeed, very often it was not possible to take a piece as large as 4 in. square from a gas cooker. Whereas the weight loss was something which the enamellers wanted to be able to measure, the customer was interested in loss of gloss. Even though it might take a long time to abrade a particular enamel through a millimetre, once the skin was lost it would still be unsatisfactory for the customer, because the gloss started to go and the dirt got in.

He understood that the new machine was developed by the Sub-Committee because the British Standard test was not very satisfactory; but he asked if there were any relationship between the two. Table II in the paper gave figures for three enamels of different softnesses; he asked what softness figures were given in the British Standard test, and whether they gave the same numbers or varied. The prime aim of the gas industry was to test complete appliances.

DR. NIKLEWSKI replied that the Sub-Committee's aim was to develop a testing machine for use in an enamelling plant to differentiate between one enamel and another. The new testing machine was not one that could be applied by someone who was buying appliances, and it was not possible to devise a method which could give an exact measurement without destroying the appliance.

The Sub-Committee did not compare their test with the British Standard, which was useless to them as enamel users; something more exact was required.

MR. A. BIDDULPH agreed with Dr. Niklewski regarding the reason for developing the new machine; undoubtedly the loss of weight was something which could be written on to paper, and the measurement of that loss was the prime purpose of the Sub-Committee. At the same time he agreed with Mr. Dunning that from the point of view of the user the loss of gloss was the factor that mattered.

In describing the new test the Sub-Committee had established that they did not depend on measurements taken after abrading for five minutes; they wanted to go on for 20 or 30 minutes, for the longer they continued the abrasion the less was the margin of error.

After five minutes they could detect some loss of gloss. He suggested it might be worth while considering whether, not to replace the new test but, as a supplement to it, it might be possible to devise some means of abrasive attack which was less severe, using perhaps a softer sand, plastic balls instead of steel balls, or something similar, whereby it would be possible to achieve in 30 minutes a degree of loss of gloss which with the present test was obtained in two or three minutes.

DR. NIKLEWSKI replied that the tool suggested by Mr. Biddulph would be very valuable, but also very expensive. Probably some frit manufacturers could acquire it and use it, but he felt it would be a little too much to ask the ordinary enamellers to go to that expense. The Americans had their method; but the effort of the Sub-Committee was to produce something which the ordinary enamellers could acquire.

MR. H. W. WADE said it was assumed that the sand alone was the abrasive material, and he asked if there were not some abrasion from the steel balls. Could they not also be standardized for hardness?

DR. NIKLEWSKI replied that the Sub-Committee had introduced the stainless-steel balls mainly to avoid roughness, etc., but the difference of hardness of the stainless-steel balls was not investigated. The balls did not abrade so much as the sand, and the abrasion of the sand on the harder enamels was very little. It was necessary for the weight of the charge to remain constant and that might mean adding one more ball after a time.

Positioning of Test Panel

MR. J. TAYLOR said it seemed that the positioning of the test panel was precise; if it were not, then it would seem that one was presenting a new surface to the machine.

DR. NIKLEWSKI pointed out that on the machine there were four pins by means of which the sample panel was locked in position, and there was also a rubber washer, so that care was taken to use the same surface for abrading.

MR. RYDER suggested that the important matter was the flatness of the sample panel; and he asked whether, if there were a little curvature on it or

even a little orange peeling, it would have an effect. It would appear that there would be more abrasion on the hills than in the dales.

DR. NIKLEWSKI said he did not know to what extent there was irregularity of the surface of the enamelled sample.

MR. A. W. MURDOCH agreed that it was important to have the surface of the sample panel very smooth. With two samples of the same enamel, one of them having an orange-peel surface and the other being very smooth, a difference would be shown by the P.E.I. test, and he supposed that would be the case also with the Sub-Committee's new test.

THE CHAIRMAN (Mr. J. W. Gardom) said he imagined that would be very much dependent on the weight of the abrasive charge.

MR. MURDOCH added that that was why he was in favour of an earlier remark that the significant part of the test was the surface, not the sub-surface. Once the surface was disturbed, the sub-surface was less important because it corroded so quickly. So that he supported the suggestion to extend the period of the test ; it would be a good thing to look more closely at the surface abrasion, which occurred in the first 2 to 5 minutes, and to try to extend the time to 30 minutes or as long as possible, either by using a different abrasive or reducing the amount of the same abrasive.

MR. W. THOMAS asked if there was a definite break in the curve as the sample passed through the test.

DR. NIKLEWSKI replied that the curve was continuous and it became more and more steep as the test proceeded. The surface of the sample would abrade, but it was not possible to indicate particular points at which it would abrade.

MR. BIDDULPH added that there had been a different distribution of grain-sizes in the abrading materials as between two screens, which affected the results. A glass sand had been used, with grain size between 0.3 and 0.4 mm.

Abrading Organic Finishes

MR. IAN W. MURDOCH asked if the Sub-Committee had used the abrading machine on any of the organic finishes. Some claims had been made, he said, that those finishes were abrasion resistant, but the difference in the results obtained as between those finishes and enamel was fantastic ; the enamel was very much ahead.

DR. NIKLEWSKI replied that he had not tested paints in the new machine ; but he agreed that the results obtained with them and with enamels would be very different.

MR. RYDER asked whether the machine had become available for purchase and whether the manufacturers had given it a particular name.

DR. NIKLEWSKI replied that it was available and he believed the price was about £60 ; but he would prefer that an enquiry as to price should be made direct to the manufacturer. As to the name of the machine, the Sub-Committee had preserved the title " The Institute of Vitreous Enamellers Abrasion Machine."

When asked by another speaker whether the price of the machine included the steel balls, he said they were not supplied with the machine, but the manufacturers had stated that they would supply the sand and the steel balls to specification.

THE CHAIRMAN, having been concerned at one time with the manufacture of steel balls, said there was a very big variation in the surface hardness of a steel ball. They had to be polished before they could be subjected to a hardness test, and in control tests during manufacture they were dealt with in that way. Any ball manufacturers would supply a standard ball.

Abstract

ACID-RESISTANCE TESTS FOR VITREOUS ENAMELS USED IN THE CHEMICAL INDUSTRY

by G. E. Charlish, B.Sc., F.R.I.C.*

THE paper gives a general critical survey of the various methods of testing used in the determination of acid resistance in vitreous enamels, followed by a summary of the results of tests made in acid media. Reference is also made to results and conclusions previously published and the author discusses in detail many further tests which he has made since his earlier paper was prepared.

Although the work described is incomplete in several respects it has established that :

(a) No reliable estimate of the acid-resistant qualities of a highly-acid-resistant enamel can be made from a visual or qualitative assessment of the appearance of the surface after tests, nor from a single quantitative test in an acid medium. Repeated testing is essential if any proper assessment is to be made of the acid resistance of the enamel.

(b) Very misleading conclusions may be drawn if fresh medium is not employed for individual tests since the corrosion rate is greatly affected by the length of time for which the test sample is exposed to the medium.

(c) Apart from rare exceptions highly-acid-resistant enamels became more resistant to attack the more they were subjected to exposure to acids.

(d) Of the media in which tests have been made, boiling concentrated hydrochloric acid has proved to be the most corrosive.

(e) The corrosion rate increases as the temper-

*T. and C. Clarke and Co. Ltd.

ature of the medium is raised. Boiling often causes a marked increase in the corrosion rate. The results of quantitative acid-resistance tests are sometimes quoted in terms of the mean rate of loss of weight per unit area per unit time based on a single test of 30-days' duration. The author is of the opinion that a continuous test of 30 days bears little resemblance to the conditions to which enamelled items are most frequently exposed when installed on the plant. Apart from storage vessels, or items installed on a continuous plant, it is unlikely that an enamelled item would be exposed in service to an unchanging medium for a month on end. In batch-type processes it is usually exposed to regular changes of media at frequent intervals. The author considers, therefore, that it would be preferable to express the results of corrosion tests in terms of the weight lost per unit area per unit time in a series of 7-hour or 24-hour tests, in which the medium is renewed for each individual test.

Results of corrosion tests on chemical plant enamels are sometimes expressed in terms of inches penetration per year, as is common practice with metals. The method is not entirely satisfactory for metals and life expectancies of metal plant items estimated from the results are often far from reliable, for instance, when pitting and other forms of local attack are likely to occur. So far as enamel coatings are concerned the method provides a yardstick for comparing different enamels tested under similar conditions, but no more than this, and caution must be observed before extrapolating the results to estimate service life under plant conditions. The service life of an enamelled item will depend on the particular media involved in the process, the thermal conditions, the frequency with which the media are renewed and the quality of the enamelling, with which may be associated the design of the item concerned and the quality of the basis metal.

In over fifteen-years' experience the author can recall only one example where the failure of a major item of chemical plant could be ascribed directly to an intrinsic lack of sufficient acid resistance in the enamel. The enamels applied by the leading suppliers of enamelled chemical plants can generally be assumed to have adequate resistance to most acid conditions likely to be encountered. More important than any minor differences in acid-resistant qualities is that the coatings shall be continuous initially and remain so in service.

DISCUSSION

MR. S. E. A. RYDER remarked that, whatever was done, the sort of requirements discussed in the paper should not be brought into B.S. 1344!

DR. B. K. NIKLEWSKI said that what puzzled him was the mysterious behaviour of acids when used for more than one test, and he wondered whether analytical work could be done on the acids to determine whether or how they could form protective films.

MR. CHARLISH replied that such work as Dr. Niklewski had envisaged would involve quite a lot of investigation from the academic point of view, and his organization had not the facilities to do it. He would like to follow it up, because it called for delicate analytical work on the acids.

DR. NIKLEWSKI said that he had examined many thousands of vessels which had required re-enamelling. It was true of the dry process and the wet process enamels that failure was very seldom due to acid attack ; it was due mostly to thermal shock. Vessels often had excellent appearance when on test, but within six months or so they would be returned for re-enamelling. The enamel should be thermal shock proof as well as acid proof and he invited comment on that matter.

MR. CHARLISH, in reply, quoted the final sentence of his paper, which his friends in the chemical industry considered should be printed in letters of gold : " More important than any minor differences in acid-resistant qualities is that the coatings shall be continuous initially and remain so in service."

In only one instance, he continued, had he ever seen a major item of chemical plant which had failed through lack of acid resistance. It was necessary, of course, to try to achieve still more acid resistance, but it was far more important to achieve a good continuous coating. He agreed that thermal shock failures occurred ; but another factor was the occurrence of odd discontinuities and defects which led to a local defect, and off came the enamel.

There were just as many problems in testing the effects of alkalies as of acids and the effects were much the same, depending on the duration of the tests.

Mr. Charlish then showed a graph illustrating the results obtained for four enamels with 1/20th per cent Na_2O, and also with 0.5 and 1 per cent. He indicated also the results for borax glass, to give some clue as to how the resistance of the four enamels to boiling alkalis compared with that of the borax glass.

Speaking of tests on a domestic-type enamel in 20 per cent caustic soda, he said the results were astonishing. In the first test the weight loss was less than 1 mg., in the second test it was 4½ mg. and in the third test it was about the same. After testing for 12 periods of 7 hours, using fresh alkali for each test, the weight loss came up to more than 60 mg. per test.

Abstract

THE INFLUENCE OF CHEMICAL COMPOSITION OF ENAMEL ON ITS ALKALI RESISTANCE

*by A. N. Revell**

THE paper adds to the small store of technical information available on the problem of alkali resistance in enamel, a subject which unlike that of acid resistance, has been much neglected. The author outlines the mechanism of the attack and says that the basic difference between acid and alkali attack seems to be that general dissolution of the glass or enamel surface occurs, while in the case of acid attack, the dissolution takes place through the silica network. He also confirms that the mechanism of attack differs between various alkaline solutions. An illustration of this is the case of a lead-bearing acid-resistant enamel which was stood in cold, 2½ per cent sodium carbonate solution for several hours and was visibly unmarked. The sample was then placed in 2½ per cent "Tide" at 75°C. for 25 minutes. The surface which had been exposed to sodium carbonate was apparently unaffected while the rest of the surface was badly attacked.

For some time in this country only visual, qualitative methods of determining the chemical properties of enamels have been used, in this particular case by heating the sample in an alkaline solution for some arbitrary time and at some arbitrary temperature, and it would seem preferable to use a method based on a property of the enamel, for instance loss of weight or loss of gloss.

The author discusses the simple method used to measure the alkali resistance of a range of enamel frits to assess the influence of many of the atomic groups found in vitreous enamels and confirms the beneficial influence of zirconium, titanium, alumina and zinc in particular and also the deleterous effect of lithia. The results given are presented with many graphical and tabular illustrations.

DISCUSSION

THE CHAIRMAN (Dr. B. K. Niklewski) said the paper presented results from a comprehensive research. Some of the glasses were said to be alkali-resistant by reason of their application to metal, and so on. But enamel surfaces could change greatly in respect of their behaviour in alkaline conditions, merely because of differences in the process of their application to metal.

*Main Enamel Manufacturing Co. Ltd.

MR. REVELL said the reason why enamels were applied by the dry process was that it avoided the use of clay electrolytes, and so on. It was assumed that the use of the dry process would minimize the effect of alkalis on the structure of the enamel.

MR. A. BIDDULPH complimented Mr. Revell on a very comprehensive piece of work which was of fundamental importance, even though, as he himself had remarked, it might not produce results straight away.

Towards the end of the paper there was reference to the differences obtained with an antimony enamel and an acid-resisting titanium enamel. Undoubtedly there were differences ; but one would not like it to be accepted generally that all titanium enamels gave a high reading for resistance and all antimony enamels gave a low reading. There were in use antimony enamels which had a very high degree of resistance to detergents and other alkaline solutions.

MR. REVELL remarked that when he had referred to the antimony and titanium enamels he was not generalizing, but was merely quoting one or two examples.

DR. NIKLEWSKI added that acid-resisting antimony or leadless enamels had quite good alkali resistance in the dry process. In the wet process the titanium enamels showed a rather poor alkali resistance. There could be exceptions, of course, but in general that was the finding.

MR. C. M. PATRICK (Borax Consolidated) raised the point that, in the work discussed in the paper, lithium oxide had replaced sodium oxide percentagewise. But in the literature covering the work done on glasses it had been shown that lithium oxide, replacing sodium oxide on the molecular basis, did in fact produce improved durability ; that was against what was reported in the present paper.

MR. REVELL said it was quite obvious that the results obtained would have been entirely different if replacements had been made on the molecular basis. He quite agreed with Mr. Patrick's remark on the effect of the change to lithium.

DR. NIKLEWSKI commented that the research worker had to make up his mind about using the molecular or the percentage basis for making exchanges. Quite a lot of the American work was done on a percentage basis in connexion with enamels, the ceramic industry, however, used the molecular basis. The results were quite often different.

In connexion with the work reported in the present paper there had been discussion for some time on which basis to use, and it was decided that for practical purposes it would be wise to use the percentage basis.

(*Conference report to be continued*)

ADSORBTION OF CYANIDE IONS

on Weakly Basic Anion Exchange Resins

*By GUNNAR GABRIELSON

Introduction

AMONG the most widely used electro-plating baths are those in which the metal to be deposited is contained in a complex cyanide ion. Common types are *e.g.* copper, silver, gold, zinc, and cadmium cyanide solutions and in all these baths there is an excess of sodium cyanide above that used to form metal complexes. This is called the free cyanide content and must be carefully controlled, as an excess or a deficiency of free cyanide cause bad deposits.

The most important of the above-mentioned solutions are the copper cyanide baths, which are the subject of the present investigation, carried out in order to evolve a new analytical method for the determination of the free cyanide content in these solutions.

Methods for the Determination of the Free Cyanide Content

The cyanide copper-plating baths consist essentially of water solutions of copper cyanide in sodium (or potassium) cyanide together with an excess of alkali cyanide (the free cyanide content). There has been some doubt in the literature regarding the structure of the complex cyanide ions in these solutions, but it is assumed that different ions are formed according to the following equations :

$$CuCN + CN^{1-} \longrightarrow Cu(CN)_2^{1-} \quad . \; . \; . \quad (A)$$

$$CuCN + 2\,CN^{1-} \longrightarrow Cu(CN)_3^{2-} \quad . \; . \; . \quad (B)$$

$$CuCN + 3CN^{1-} \longrightarrow Cu(CN)_4^{3-} \quad . \; . \; . \quad (C)$$

The commonly used method to determine the free cyanide content is titration with silver nitrate, using potassium iodide as an indicator. This method has also been used in an attempt to determine the different copper cyanide complexes. It was found that the main ion is $Cu(CN)_3^{2-}$[1]. In an earlier paper *Glasstone*[2] from potential measurements concluded, that the principal ions are $Cu(CN)_2^{1-}$ $Cu(CN)_3^{2-}$. Also *Rothbaum*[3], measuring the static potential of Cu in cyanide solutions, found that in most plating baths the principal ion present is $Cu(CN)_3^{2-}$.

*Department of Engineering Chemistry, Chalmers tekniska hogskola, Goteborg, Sweden.

As is seen from the above the titration method leads to the same result regarding the copper complexes formed as the potential-measuring methods. In spite of this it is thought that the titration method does not give accurate values when used for the determination of the free cyanide content, as the equilibria (A), (B), and (C) above are displaced to the left when the cyanide ions are removed through the formation of insoluble silver cyanide. Hence too high a value of the free cyanide content would result. How large the error will be depends upon the rate at which the copper cyanide complexes dissociate.

Adsorption of Cyanides on Anion Exchange Resins

Several investigations on the adsorption of cyanide and complex metal cyanide ions on anion exchangers have been reported in the literature. *Hussey*[4] adsorbed gold cyanide on the weakly basic resin Amberlite, IR-4B at a *p*H value > 10. The capacity was found to be low. Also *Burstell* and co-workers[5] found that an anion exchanger of weakly basic type has a much lower capacity for gold cyanide complexes than strongly basic resins, the capacities reported being 0.1 and 3 meq. per gram respectively. *Walker* and *Zabban*[6] carrying out experiments for the treatment of plating-room waste cyanide solutions, also found that weakly basic resins have low capacities for the cyanide complexes. Because of this, strongly basic anion exchangers have been used, *e.g.* for the recovery of cyanide complexes from gold-bearing cyanide solutions[7], [8]. In contrast to the above, however, *Aveston* and co-workers[9] found that complex metal cyanides, especially the gold-cyanide complexes, are adsorbed rather strongly on a weakly basic resin. *Kunin* and *McGarvey*[10] passed a hydrochloric-hydrocyanic acid mixture through a layer of a strongly basic anion exchanger. Both acids were adsorbed. With a weakly basic resin they report that only hydrochloric acid is adsorbed.

These results suggest that it would be possible to separate the free cyanide from the complex

copper cyanides by means of a weakly basic resin as the complex ions are adsorbed, but not hydrocyanic acid[10]. When passing a cyanide copper plating solution through a weakly basic resin the complex copper cyanide ions would therefore be adsorbed and the free cyanide pass through. If the complex ions are so stable that no displacement of the complex equilibrium would occur during the sorption and washing steps it would be possible to determine the free cyanide in the combined effluent and wash water.

Experimental

Apparatus : The anion exchangers used were Amberlite IR — 45 (Rohm & Haas Co., Philadelphia, U.S.A.) and Dowex — 3 (The Dow Chemical Co., Midland, Michigan, U.S.A.), which both are of weakly basic type. The particle size was 0.15 to 0.30 mm. in air dry condition. Ion-exchange columns of ordinary type were used, the diameter and height of the resin layer being 10 mm. and 150 mm. respectively. In the experiments the anion exchangers were used both in free base form, as delivered from the manufacturers, as well as buffered to different *p*H values. In the latter case the resin, before the experiments, was treated with dilute buffer solutions, until the influent and the effluent had the same *p*H value. The flow-rate during these operations was about 5 ml. per minute. The solutions were prepared from C.P. chemicals.

The supposition for the above outlined analytical method for the determination of the free cyanide content using weakly basic resins is of course that no cyanide ions are adsorbed on resins of this type. In preliminary experiments it was found that the adsorption of cyanide ions on Amberlite IR — 45 was considerably higher than on Dowex — 3 (Fig. 1) and this difference must depend on different structures of these resins, differences which, however, are not known in any detail. Because of this Dowex - 3 was chosen for the experiments described below.

A solution containing 5 gm NaCN per litre was prepared and 20 ml. of this solution were passed through the resin, buffered to different *p*H values. After washing with 50 ml. distilled water the cyanide content in the combined effluent and wash water was determined by titration. The results are presented in Fig. 1.

As seen from this figure the cyanide ions are adsorbed rather strongly at lower *p*H values. The adsorption decreases appreciably at higher *p*H values in accordance with the fact that weakly basic resins are mostly un-ionized and inert at higher *p*H values[11]. Also at *p*H 14 there is, however, a distinct though rather low adsorption of cyanide ions (about 5 per cent.). Moreover it was found that the complex copper cyanide ions

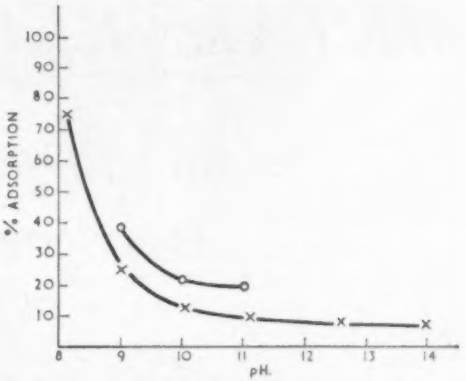


Fig. 1.—Adsorption of cyanide ions on Dowex-3 and Amberlite IR-4B at different pH values.
Flow-rate : 5 ml. per minute.
Particle size : 0.15 to 0.30 mm. in air dry condition
× adsorption on Dowex-3.
O adsorption on Amberlite IR-45.

were not quantitatively retained by the resin at *p*H values higher than about 12. Because of these facts the free cyanide content in cyanide copper plating solutions could not be determined in this way.

It seems probable that the adsorption of cyanide ions by weakly basic resins are caused by van der Waals forces. If the resin, after the passage of the cyanide solution, was washed with another liquid than water, the adsorbed cyanide ions might possibly be desorbed. As a wash, liquid ethyl alcohol was chosen, both 50 per cent. and 96 per cent. ethanol being used. No cyanide could, however, be detected in the effluent and consequently no desorption occurred at the washing with ethanol.

Another possibility would be to pretreat the resin with a large excess of cyanide ions, so that all " active " points of the resin are occupied by cyanide ions. In order to perform this a cyanide solution was passed through the resin, until the cyanide concentrations in the effluent and the influent were the same. About 300 ml. N. NaCN solution was used for this operation. After washing with distilled water, 20 ml. of the solution, containing 5 gm. NaCN per litre, was passed through the resin. The whole amount of cyanide, after washing with 50 ml. distilled water was recovered in the effluent and no adsorption had consequently occured. Thereafter a copper cyanide solution, containing 25 gm. CuCN and 35 gm. NaCN as a commonly used electroplating bath, was prepared and 10 ml. of this solution consumed 13.4 ml. 0.1 N. $AgNO_3$ at direct titration ; 10 ml. of the

(*Continued in page* 441)

METAL RECTIFIERS

for Electrolytic Processes

A REVIEW OF PAST AND PRESENT DEVELOPMENTS

By J. G. BARTHOLOMEW*

METAL rectifiers, or solid-state semi-conductors as they are sometimes called, are nowadays widely employed throughout the whole field of electrical engineering. In power engineering their principal application is to provide direct, or uni-directional, current from an alternating-current supply source. They have thus proved very popular for electrochemical applications of which electroplating represents an important branch.

This article will attempt, in the light of modern technical advances, to consider the relevant merits of the various types of rectifier available and assist the plater in selecting the type most suitable to his particular needs.

The properties of metal rectifiers were first demonstrated in the early 1920's, and their use and importance in the electroplating industry has been recognized to such an extent that over 90 per cent of electro-plating shops in this country now use rectifiers for their d.c. power supply.

A rectifier may be regarded as a device which will allow current to pass more freely in one direction than in the other. When a voltage is applied to a normal conductor, the current which flows is independent of the polarity of the voltage, *i.e.* alternating current would flow in the conductor as readily as direct current. This law is generally obeyed by composite conductors but, in certain physical or chemical combinations, the current varies depending on the polarity of the voltage applied. Such combinations are said to exhibit "asymmetric conductivity" and, hence, the term semi-conductor. This term simply means that a semi-conductor will pass current more freely in one direction than in the other. The resistance in the forward direction is low and the resistance in the reverse direction is high. This resistance cannot simply be expressed in terms of ohms, since the relationship between the current passing in either direction and the voltage which drives it is not a constant but varies over the range of applied voltage. In other words, a rectifier has a non-linear characteristic. There is, of course, a slight voltage drop in the forward direction, the value of which gives a rectifier its forward characteristics, and there is also a slight current leakage in the reverse direction and this is represented by the reverse characteristic. Rectifier elements or diodes are manufactured in a wide variety of sizes, and it is the job of the designer to select the correct type for any particular application and arrange sufficient diodes in series to withstand the peak inverse voltage of the circuit and to allow sufficient parallel sub-circuits to handle the maximum current for which the complete equipment is rated.

The first plating rectifier was the copper-oxide type, and, while it laid the foundations for future metal rectifiers for plating, it suffered from the disadvantage of being extremely bulky for normal plating currents, and was superseded by the selenium rectifier introduced in 1940. Selenium rectifiers are much less bulky than copper oxide and were firstly oil immersed for plating-shop work to protect the rectifier from corrosive atmospheres. Later, a water-cooling technique was developed, as an alternative.

Selenium, as a basic chemical, is found in many parts of the world, usually in small quantities as selenides of heavy metals. It is also obtained from the flue dusts of processes employing sulphide ores and from the anode slimes in copper refining. It is sprinkled in a pulverized vitreous condition on to a cold base and heated. Under the influence of heat the vitreous selenium at first becomes plastic and an applied pressure causes it to flow and form a homogeneous layer of uniform thickness. A counter-electrode, usually a low-melting-point alloy of either lead, tin, bismuth or cadmium, is sprayed on to the surface of the selenium and a small current passed in the reverse direction for a few minutes to increase the reverse resistance.

About ten years ago it was discovered that an excellent rectifier could be prepared on semi-conducting germanium, and it was found that a

*Westinghouse Brake and Signal Co. Ltd. (Rectifier Division).

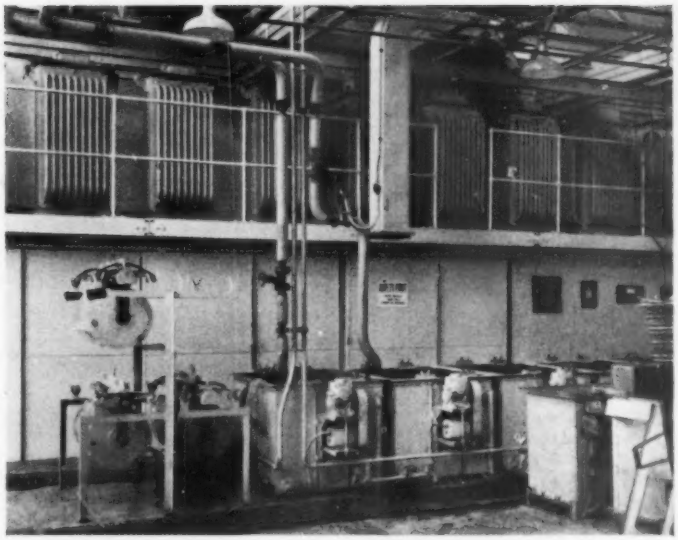


Fig. 1.—Westalite oil-immersed plating rectifiers, totalling 6750 amp., installed on a gantry. (Courtesy of Gillette Industries Ltd.)

large area positive-negative junction could be prepared by a process of diffusing indium into mono-crystalline germanium, and today diodes of this character are in full production. Germanium is a metal found in small quantities in many coal or zinc deposits. It is extracted and refined to a high degree of purity, and the resultant grey metallic material is pulled into a mono-crystalline formation which is then specially cut to form small wafers. An indium button is diffused into the germanium wafer, the bond between the germanium and the indium forming the rectifying junction which is assembled to a hermetically sealed housing, in much the same way as a radio valve. An inert gas, usually argon, is used to fill the housing and keep it completely free from all extraneous forms of attack likely to be met in the plating shop.

Germanium rectifiers have been developed commercially over the past several years and it was unfortunate that in the early days of their development a number of germanium equipments manufactured abroad were put into service before the problems of diode rating and overload protection were fully understood. This resulted in some adverse criticism of this remarkable new development in rectifier engineering.

In this country, there was no need to attempt to market germanium plating rectifiers before the completion of their development, as the demand was already being met by the popular and well established oil-immersed selenium set. However, when the fully developed, correctly rated and adequately protected water-cooled germanium set emerged, it was offered to the trade and immediately proved popular.

A rectifier manufacturer with long experience of plating-shop power supplies since the inception of metal rectifiers, is, of course, well aware of the conditions his designs must meet, and the protection and rating problems were thus systematically solved.

Overload protection of a germanium rectifier is designed to disconnect the equipment from the supply in the event of a heavy overload or a short circuit, and the characteristics of the fast-acting relay which looks after these conditions are such that the diodes are protected against all high-level faults. Low-level overloads are dealt with separately and if the overload goes beyond the limit of which the rectifier diodes themselves are capable, then the rectifier itself is switched from the circuit by the low-level fault protection. The equipment is designed to withstand a sustained light overload and also to withstand short-duration heavy overloads of the type normally encountered during the operation of loading and unloading of a plating vat, without the overload protection operating unnecessarily and without harmful effect on the rectifier.

The germanium rectifier has non-ageing characteristics and a very high electrical efficiency, and when correctly designed is at least as reliable as any other form of d.c. power supply.

More recently, a positive-negative junction has been developed on semi-conducting silicon, but at the moment the cost of producing this type of set, suitably protected, is rather high, since its protection raises problems very similar to those of germanium. Silicon metal is obtained from its oxide silica. It is refined to a high degree of

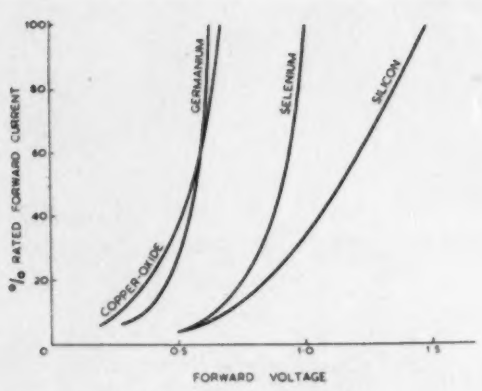


Fig. 2.—Typical forward characteristics.

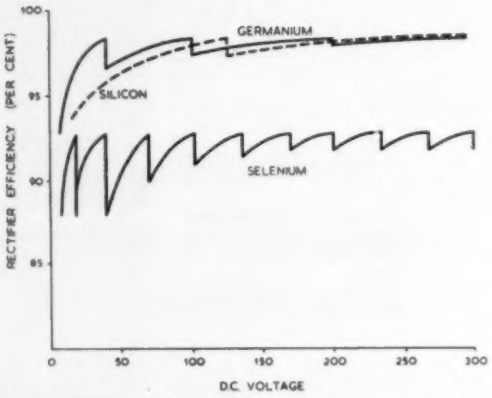


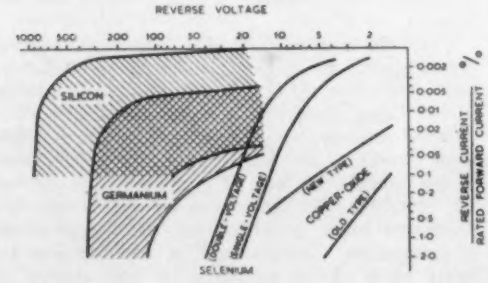
Fig. 4.—Efficiency of rectifiers at various d.c. voltages.

purity, drawn into large mono-crystals and cut into wafers. A thin plate of aluminium is bonded to and diffused into the silicon wafer and the silicon forms the rectifying junction. Silicon has many technical advantages over selenium rectifiers and the fields of application most likely to benefit from these advantages will be those needing medium and higher voltage supplies, such as electrostatic plants, traction stations, or where high ambient temperatures occur normally, such as in the tropics.

Comparison of Forward Characteristics

Selenium rectifiers operate at low current densities, while the new semi-conductor, germanium, can operate at current densities some thousand times this value. In making any comparison of forward characteristics the main concern is the current at which the rectifier can safely operate, rather than the current density, and a scale showing the percentage of full load current allows a direct comparison of the forward characteristics. It can be seen from Fig. 2 that the voltage drop through a germanium rectifier is less than that of selenium for the same current ratings.

Fig. 3.—Reverse characteristics plotted on a logarithmic scale.



Comparison of Reverse Characteristics

A direct comparison of the reverse characteristics can be made by plotting the reverse current, expressed as a percentage of the full-load forward current against the reverse voltage, as shown in Fig. 3.

In the production of selenium rectifiers it has proved economical to employ a certain pass limit for the reverse characteristics, rejecting the few which fail to meet the limit, and accepting those of better-than-limit characteristics as standard production.

With the normal processing of germanium rectifiers, the diodes produced show various reverse characteristics, and these can be graded so as to employ those with higher voltage characteristics in applications needing higher d.c. voltages, as, for example, where some 60 volts d.c. is required for chromic-acid anodizing.

Efficiency

Since lower operating costs result from higher electrical efficiency of the power plant, it is well worth remembering that germanium rectifiers offer the highest efficiency when comparison is made with other types of rectifier, particularly at the low voltages employed for electroplating.

Fig. 4 illustrates the efficiency of the various rectifiers against a base of d.c. voltage ; the steps in the curves arise where it is necessary to increase the number of series elements when the safe operating limit has been reached. A comparison of the efficiency of the rectifier alone, considered at various d.c. voltage levels, can be seen in Table I, and it will be noticed that germanium offers the highest efficiency at voltages used by electroplaters,

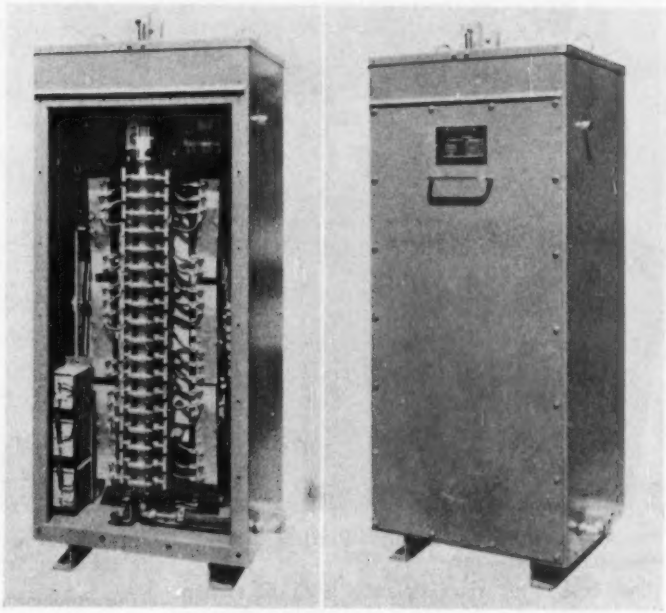


Fig. 5.—A germanium 8-volt, 1000-amp. water-cooled rectifier showing the arrangement of the diodes and the compact appearance with the front cover replaced.

and at higher voltages there is little to choose between germanium and silicon. The modern selenium rectifier is less efficient than the monocrystalline rectifiers but, nevertheless, an efficiency of over 90 per cent. has been achieved in large installations.

It must be appreciated that the losses in the transformer, cables and busbars, fuses and shunts must also be taken into account, and as these are much the same for each type of rectifier, the difference in the overall efficiency is, to some extent, masked by these additional losses.

The manufacturer has a choice of circuits which enables him to make the best economic use of the rectifier. A hexaphase circuit with a low ripple content is usually employed.

Table I

D.C. Voltage	Efficiency (Per Cent.)		
	Selenium	Germanium	Silicon
6	85	91	83
12	91	95	90
25	91	97	94
50	91	97	97
100	92	97	97
500	92	97	98
750	92	98	98

This circuit comprises six sections of rectifier, each fed from one phase of the six-phase output from a transformer, the outputs from these six rectifier sections being connected together to form one pole of the d.c. supply. The other pole of the d.c. supply is derived from the centre point of the transformer secondary which comprises in effect two separate star-connected windings having their mid-points connected together through a reactor. The transformer primary winding is, of course, arranged for connexion to a 3-phase supply.

Cooling

The rating of a rectifier is dependent on the efficiency of its cooling system. Selenium rectifiers have, generally speaking, been oil-immersed in order that the complete rectifier is protected against bad atmospheric conditions, as encountered in some plating shops. The bulk of an oil-cooled rectifier is often a problem for the space-conscious plater, since valuable space could accommodate another plating unit.

Germanium rectifiers, being hermetically sealed, afford maximum protection against the effects of plating-shop fumes, and it is usual in the case of this type of rectifier to employ water-cooling. By adopting water-cooling, the diodes can be maintained at a temperature only slightly above that of the water, since a good water-cooled assembly provides very good thermal conductivity from the

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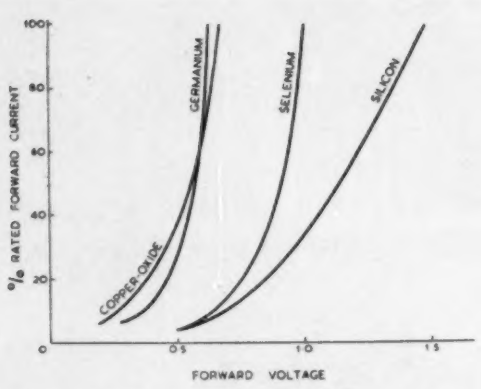


Fig. 2.—Typical forward characteristics.

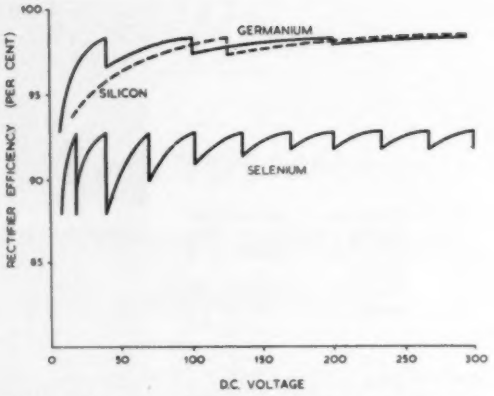


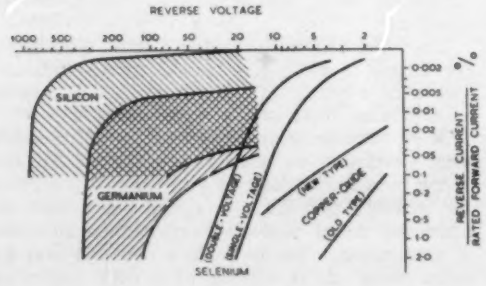
Fig. 4.—Efficiency of rectifiers at various d.c. voltages.

purity, drawn into large mono-crystals and cut into wafers. A thin plate of aluminium is bonded to and diffused into the silicon wafer and the silicon forms the rectifying junction. Silicon has many technical advantages over selenium rectifiers and the fields of application most likely to benefit from these advantages will be those needing medium and higher voltage supplies, such as electrostatic plants, traction stations, or where high ambient temperatures occur normally, such as in the tropics.

Comparison of Forward Characteristics

Selenium rectifiers operate at low current densities, while the new semi-conductor, germanium, can operate at current densities some thousand times this value. In making any comparison of forward characteristics the main concern is the current at which the rectifier can safely operate, rather than the current density, and a scale showing the percentage of full load current allows a direct comparison of the forward characteristics. It can be seen from Fig. 2 that the voltage drop through a germanium rectifier is less than that of selenium for the same current ratings.

Fig. 3.—Reverse characteristics plotted on a logarithmic scale.



Comparison of Reverse Characteristics

A direct comparison of the reverse characteristics can be made by plotting the reverse current, expressed as a percentage of the full-load forward current against the reverse voltage, as shown in Fig. 3.

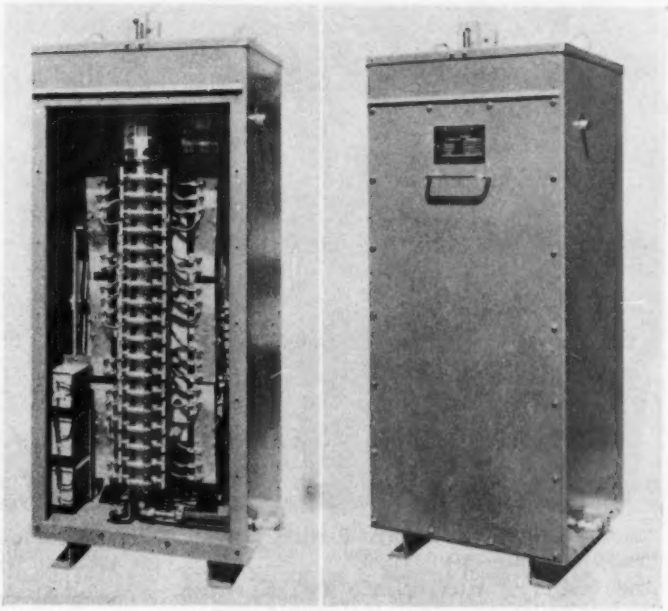
In the production of selenium rectifiers it has proved economical to employ a certain pass limit for the reverse characteristics, rejecting the few which fail to meet the limit, and accepting those of better-than-limit characteristics as standard production.

With the normal processing of germanium rectifiers, the diodes produced show various reverse characteristics, and these can be graded so as to employ those with higher voltage characteristics in applications needing higher d.c. voltages, as, for example, where some 60 volts d.c. is required for chromic-acid anodizing.

Efficiency

Since lower operating costs result from higher electrical efficiency of the power plant, it is well worth remembering that germanium rectifiers offer the highest efficiency when comparison is made with other types of rectifier, particularly at the low voltages employed for electroplating.

Fig. 4 illustrates the efficiency of the various rectifiers against a base of d.c. voltage ; the steps in the curves arise where it is necessary to increase the number of series elements when the safe operating limit has been reached. A comparison of the efficiency of the rectifier alone, considered at various d.c. voltage levels, can be seen in Table I, and it will be noticed that germanium offers the highest efficiency at voltages used by electroplaters,



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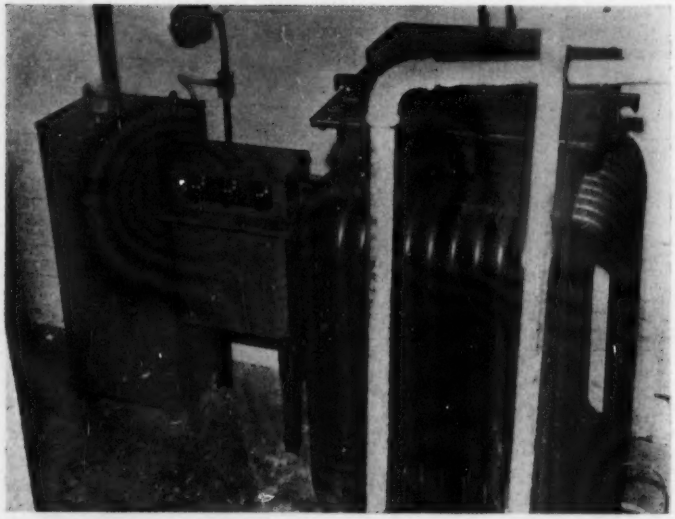

Fig. 6.—A selenium and a germanium rectifier, both having an output of 8 volts-1000 amp, installed side by side, showing the considerable space saving advantage of one type over the other.
(Courtesy by Harris Plating Works Ltd.)

Metal Rectifiers for Electro-Plating

(*continued from page* 435)

diode base to the water coolant. With this system, the problem of maintenance is simplified since the water supply can be readily turned off and repair work started. The weight of a water-cooled equipment is very much less than that of the equivalent oil-cooled set and can be as low as 1/5th ; furthermore ,a natural oil-cooled equipment is to some extent influenced by the ambient temperature, whereas water for cooling purposes is much less dependent on ambient temperature although sites where there is a risk of water freezing should, of course, be avoided. For these various reasons, water cooling is rapidly gaining popularity, particularly in plating shops where the uncontaminated coolant can be utilized for rinses and dips when it leaves the rectifier set.

Types of Control

The control of a rectifier output is effected by means of varying the input supply voltage to the main transformer. Various types of auto-transformers are employed for this purpose. They can be either tapped-winding transformers controlled by switches, or off-load links ; alternatively, they can be stepless regulators in which the principle of control is to vary the position of a current collecting brush along a bared section of an auto-transformer winding. This type of stepless regulator can be either hand-operated or motorized, which lends itself to various forms of automatic control. In modern automatic plating plants, it is necessary to control the current automatically, and the current density or the voltage at the plating vat.

This is effected by an automatic signal at the plating vat feeding back to the regulator motor control and raising or lowering the voltage applied to the main transformer automatically.

Research work continues unceasingly in a quest to improve plating-shop supply plant by incorporating any new development considered beneficial to this type of equipment. However, now that the water-cooled germanium rectifier has been fully developed and its attractions are rapidly becoming apparent to all plating-plant users, it seems unlikely that there will be another major change for some years to come.

Anti-Corrosive Protection for Coal Plant

CORROSION, one of industry's heaviest overheads, is counteracted in many different ways. At Abernant Colliery, near Pontardawe, the National Coal Board wished to combine adequate protection and a certain amount of decorative effect for a new coal handling plant and shaft structures and specified bright green Melanoid bituminous paint, available in the U.K. from Griffiths Bros. and Co., London Ltd., of Wednesfield, Staffs.

The claims for this paint are that, having a high, unvarying bitumen content, the dried film is exceptionally flexible and gives pronounced protection against the chipping action of the coal. It is also said to provide low cost protection against the corrosive atmosphere, wind and rain experienced at the colliery. Although essentially a brushing paint, but can be applied by dip or spray, skilled labour being unnecessary. It has good adhesion to metal, woodwork and concrete, and is highly suitable for surfaces subject to expansion and contraction.

Metal Finishing Technology — A Students' Guide: 5

An Introduction to the Examination Syllabus in Metal Finishing of the City and Guilds of London Institute

Compiled by A. ALEXANDER

ALTERNATING CURRENT AND APPLIED ELECTRO-CHEMISTRY

AN alternating current varies in direction, flowing backwards and forwards in a circuit in very much the same way as the air operating a pneumatic road drill. In this country the period is 1/50th of a second, that is to say there are 50 cycles per second. If the strength of the current is plotted against time it will start from zero, rise steadily to a maximum, then fall to zero, rise to a maximum in the opposite direction and again fall to zero and the curve obtained under normal conditions will be a sine wave. It will be seen therefore that the actual current flowing through a circuit at any instance of time will vary quite considerably. However, for measurement purposes it is necessary to take some type of mean value and the value chosen is called an R.M.S. (root, mean, square). This is taken because if the current is put through a heating circuit the amount of heat produced will be equal to that of a direct current of the same value.

If the current is passed through a resistance, the voltage across the terminals would vary in exactly the same way and the two curves will be in phase, that is to say, they will increase and decrease together at the same rate. If, however, instead of using a resistance, an inductance is used, *i.e.* a coil wound on an iron core, it will be found that the two curves come out of phase, which means that the voltage will build up to a maximum before the current does and by the time the current has got to its maximum value the voltage will have started to drop. If, on the other hand, a condenser is placed in the circuit the two curves will come out of phase in the opposite direction, the current building to a maximum before the voltage.

The amount of power obtainable from an electric current is proportional to the the product of the voltage and amperes, or Watts With a direct current, the reading of the two meters multiplied together will give the number of watts. The same applies to an alternating current where the two curves are in phase because at every point on the curve the number of watts will be the product of the two readings.

If, however, the two curves are not in phase then less power will be obtained. For example, using a hypothetical case in which the two curves are 90 deg. out of phase, then when the current is reading 0 the voltage would be at a maximum and when the voltage is reading 0 the current would be at the maximum. If, however, at these points the current is multiplied by the voltage, the answer is 0 in each case and, in fact, if the mean of all the points along the curve is taken it will be found that the same result is obtained because at intermediate points the power produced will be in opposite directions. Under such circumstances, therefore, although a voltmeter and ammeter reading may be taken, the amount of power obtained from the circuit would be nil.

In practice there is a certain amount of inductance in all motors, generators, etc., so that the curves are somewhat out of phase and therefore the power obtained from the apparatus is less than the product of the voltage and amperage as measured by the instruments on the circuit. The difference between the power that is actually obtained and that which might be anticipated from instrument readings is called the 'power factor.' At best, for example in the case of a pure resistance, it will be 1.0 but for most electrical apparatus, such as motors or rectifiers it will be about 0.7 to 0.9. It is obviously desirable to have the power factor as high as possible because with a low power factor current from which no useful work is obtained is being used and paid for.

As mentioned before, inductance and a condenser have opposite effects in pulling the two curves out of phase so that it is often possible to correct the one by inserting the other, thus the power factor of a motor may be considerably improved by putting condensers across it so as to bring the two curves more nearly into phase. It is advisable, therefore, particularly with larger motors and other pieces of apparatus to know what the power factor

is and to see where it can be economically corrected by such a method.

The power factor of the average rectifier varies between 0.8 and 0.9. This, however, is not due to the two curves being out of phase but to a definite distortion in the shape of the curves and in this case it cannot be corrected by inserting condensers.

Most of the apparatus in the plating shop will be running off 3-phase a.c. However, the heaters, lighting, etc., will be of single phase which, as previously mentioned, will be taken off one or other phase of the a.c. bars and the neutral. It is possible that if a much heavier load is taken from one phase than another this will produce phase distortion in the circuit and may even upset the generating station. It is therefore advisable, from time to time, to measure the current in each phase of the circuit. This can be done quite easily by means of a ' tong test ' ammeter which can be placed round one of the cables and the current in the cable checked. If it is found that one phase is carrying a much greater load than the others the cause should be investigated and, if possible, rectified.

In the average plating shop a number of different types of motors and starters will be used. A description of these can be found in any work on electrical engineering and it is not proposed to deal with them here.

APPLIED ELECTRO-CHEMISTRY

In the City and Guilds syllabus this subject comes as a second paper and is dealt with after Electro Deposition Plant and Practice and Organic Finishing. However, it is pointed out in the introduction, that each teacher should arrange his teaching syllabus to suit specific needs and it is felt that it is sometimes inadvisable to deal with plant processes until the theory underlying them has been expounded. For this reason it is proposed to deal with this matter first and to return to the other after the theoretical considerations have been dealt with.

Corrosion Theory

Probably the majority of coatings that are applied to a metal surface are used primarily to prevent or retard corrosion. Also a number of preliminary processes, such as cleaning and pickling, are tied up with corrosion although we would not normally use this title. It is therefore desirable to understand exactly how a metal surface corrodes.

Usually the surface has to be in contact with a liquid, for example water containing some corrosive material, and therefore as an introduction it is felt that it would be worth while to consider at some length the actual nature of a metal-solution interface, that is the surface of the metal which is actually in contact with the solution.

The metal surface is composed of a lattice of metal atoms and these atoms are again, each one, composed of a number of small particles, protons, neutrons and electrons, built up into small systems not unlike very miniature editions of the solar system of which the earth is a part.

Some authors have attempted to give an impression of size of these particles by trying to compare grains of sand with the earth or the sun, but the author feels that any description of this type is worthless because it is really quite impossible to comprehend sizes of this order. All therefore can be said in an endeavour to describe the size of the atom is that it is extremely small and that the particles of which it is composed are very much smaller.

It is not possible to see these atoms with an electron microscope* although it is possible to see molecules which are built up of a large number of atoms. However, by various experimental methods which it is not proposed to discuss here, the actual size and weight of both the atoms and the other particles have been calculated. What is important for the student is to try to form a mental picture of what a metal-solution interface would actually look like and what is happening there. One is inclined to think of the surface of a piece of metal as something solid because it appears to be solid to anything of reasonable size. In point of fact however, it is composed of lots of atoms so that there are cavities between them and these atoms themselves are not even solid particles. Thus small particles, like electrons, can pass from atom to atom through a piece of metal as though it were a net rather than solid surface. In some cases a small atom may be able to migrate through the metal, *e.g.* hydrogen will diffuse quite quickly through thin sheets of certain metals.

Again, it must be remembered that these atoms are not stationary but at ordinary temperatures are vibrating. The atom itself is composed of a nucelus which is built up with positively charged particles called protons and neutral particles called neutrons. Around this nucelus revolve a number of electrons which are small negatively charge particles and these can be considered as rotating round the central nucleus in more or less definite orbits. Also the electrons themselves are spinning round as they rotate.

A great deal of experimental work and mathematical theory has been expended on the structure of atoms, and the number of electrons associated with the nucleus of atoms of various metals and other elements, has been estimated and also the orbits which they occupy. In this connexion, however, it must be pointed out that the various orbits are represented by probabilities only

*Atomic Structure may be shown with an electron emission microscope.

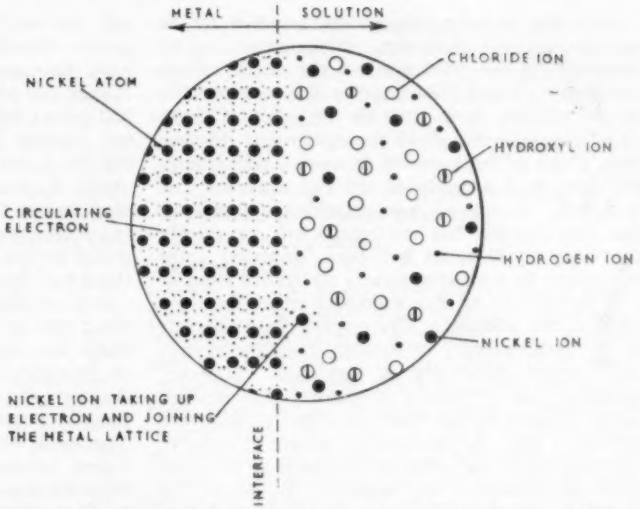

Fig. 1—Hypothetical picture of a metal-solution interface

because it is not possible to say exactly where any particular electrons will be at any particular time, but only that it is more likely to be in a certain area than anywhere else. However, from the point of view of electro-chemistry this is not particularly important and an atom is considered to be a small system composed of the nucleus and a number of electrons revolving round it in some type of orderly procession.

The fact that the particles composing the atom are in motion tends to make the atom itself vibrate and as the temperature increases this vibration also increases. It is known, for instance, that a piece of ice will present a solid surface because the atoms of hydrogen and oxygen of which it is composed, being relatively cold, are not vibrating very much. Heating the ice will cause the atoms to vibrate more violently and after a little while, when it has been heated up to 0°C. the vibration will become so strong that the atoms will no longer remain in the juxtaposition which they originally occupied but start to move about on their own and the ice will melt and become a liquid. If the water so produced is heated to 100°C. the atoms will start to vibrate so violently that they will fly about in all directions and in fact become steam.

In the case of the metal-solution interface at the ordinary temperatures being considered, the metal will be a solid (unless it is mercury) and the atoms of the metal will remain in the same relative positions to one another although they will have a small motion around their normal position. The atoms in the solution, however, will be free to move with regard to one another. Assuming that the solution is an aqueous solution of a salt of the metal under consideration the water molecules, that is to say the two hydrogen atoms and one oxygen atom which will be associated as a molecule, will be able to move quite easily in relation to other molecules and the metal surface. These molecules are really composed of two ions, a hydrogen ion and a hydroxyl ion. Most of them, however, will keep together with a group and can be regarded as un-dissociated but in a few cases the molecule may break up. The metal salt will be more or less ionized so that adjacent to the metal-solution interface there will be atoms of the metal in the solution but these atoms will not be quite like the atoms on the metal surface because they will be positively charged, that is to say they will have less electrons circulating round the nucleus than the ordinary metal atom. The electron is of course a negative particle and therefore if one or more of these electrons are taken away from the metal atom, positive charge is left on it. These electrons have become associated with the negative part of the metal salt, or the anion.

To make the " picture " more specific the case of a sheet of nickel immersed in a solution of nickel chloride may be considered. Then if the interface could be magnified sufficiently to see what was happening it would be found that a number of nickel atoms were strung together in the form of a lattice to form the surface of the nickel and that adjacent to them were a number of molecules of water interspersed among which were the nickel atoms from the nickel salt containing the same nucleus as those on the surface of the metal but having one electron less and also atoms of chlorine having two electrons more than the normal. At ordinary temperatures all these atoms will be in motion, the surface atoms vibrating but remaining approximately in their relative positions while the atoms in the solution will be spinning about in all directions.

Since the nickel atoms in the solution are in motion they will, from time to time, come up to strike against the nickel atoms of the metal. Since one atom is exactly like another it is not possible to say whether from time to time one of these nickel ions does not strike the surface and displace from it one of the atoms of the metal, taking from this atom, as it is displaced, the two electrons that it lacked. It seems quite possible, in fact, that this does happen but the result will be exactly the same if the atom has been displaced from the surface by another or merely rebounded from it.

If no electric current is flowing either from the metal to the solution or *vice versa* or from one part of the metal surface to another, then the system will remain essentially as described. Suppose, however, that a current is passed from another piece of metal to the sheet of nickel through the solution ; since the electron is a particle of negative electricity then the effect is of pumping electrons from the nickel to the solution. If one of the nickel ions which is lacking two electrons approaches the surface some of the electrons that are being pumped will get on to it and will make it into an ordinary nickel atom. It will then no longer be able to move about freely in the solution but will be attracted to the surface and there remain, taking up a position with regard to the rest of the atoms, there to form a new layer in the lattice structure or occupy a vacant position in an existing layer. If, on the other hand, we pass a current in the reverse direction, that is to say from the nickel sheet to another piece of metal in the solution, then in fact electrons are being withdrawn from the surface atoms of the sheet. It will be found, therefore, that some of the atoms in the surface layers will lose two of their electrons and under such circumstances they will become positively charged and will leave the surface and enter the solution.

This is a picture of what happens, in a somewhat simplified form, at a metal-solution interface. Mention has been made of the chlorine ions but their part in the mechanism of metal solution or deposition has not been described.

The negative ions are necessarily in the solution to balance the positive charges on the metal ions because these charges must always be exactly balanced. In the case where the nickel is dissolving from the surface the nickel atom cannot get away from the surface layer and becomes a positively charged ion unless there is available a negative ion to balance it. The term 'acceptor' ion is sometimes used in this connexion and is probably quite a good one. In the case where the nickel is being dissolved, the negative ions will tend to be brought towards the nickel surface because this will be positively charged and will attract them. When these negative ions approach the surface they will pair with the nickel ions and a molecule of nickel chloride will be obtained, two chlorine ions, associating themselves with one nickel ion. If some material which was insoluble in the solution, had been used, that is to say the metal ions would not dissolve in the solution and therefore could not move away from the surface, the chlorine ion would approach the surface until it gave up its electron and would then associate with another atom of chlorine to form a molecule of chlorine gas which would in turn form a bubble and be released at the surface of the solution.

It is very desirable for the student to try and form some type of mental picture of what is happening under the circumstances described. The current of electricity is actually composed of a stream of electrons, the size of which is so small that they can pass from atom to atom through a metal lattice. The metal atoms themselves, as previously mentioned, consist of a nucleus around which these electrons circulate and in the case of metals which conduct electricity, some of these electrons are able to leave one atom and go to another, thus it is possible to push a stream of electrons through the metal. Where a substance is composed of atoms having a more stable system it may be impossible to pass a stream of electrons through it and then we get an insulator. The solution or deposition of a metal, therefore, involves the movement of electrons. It is not always necessary, however, to apply an external current. Careful examination of the surface of the nickel sheet, will show that it is not entirely homogenous, that is to say, in some portions of it there will probably be a few atoms of another metal or, alternatively, irregularities of structure.

When this is immersed in the solution, local currents of electrons may flow from one point on the surface to another making it possible for atoms of the metal to leave the surface without the application of a current from an external surface. This is what happens when a metal surface corrodes.

In practice it is not possible to have a surface, at any rate of any finite size, which is entirely homogeneous. The nearest approach is probably a single crystal of a metal which has been carefully cut down one crystal face, but even in this case it is unlikely that the surface will be homogeneous.

In the lattice structure of the crystal, an atom somewhere in the centre will have a number of other atoms pulling on it from all sides. An atom in the surface layer however, will have a much greater pull from the back than from the front and this will cause a lattice distortion. It is probable, that the atoms in the surface layer of a single crystal will not be in quite the same juxta-position as they would be in the internal layers of the atom and having been pulled out of position

(*Continued in page* 441)

Metal Finishing Technology

(*continued from page* 440)

there will almost certainly be some cracks or voids between them. In an ordinary metal such effects will be magnified because a commercial metal is never quite pure and will have atoms of other metals spaced through its structure and appearing from time to time on the surface. Also due to the working of the surface the lattice structure of the crystals will be distorted, producing strains in the metal.

Since the surface is also multi-crystalline, various crystals will present different crystal faces. It has been shown experimentally that the energy required to remove an atom from one crystal face is not the same as from another and that certain crystal faces tend to be attacked more easily. Under all these circumstances therefore, differences of potential will be produced on the metal surface and these again may be accentuated by differences in composition of the solution at different points on the surface due to gravity, degree of aeration of other circumstances.

It would indeed be surprising, therefore, if there were not sufficient differences between points on a metal surface to another to allow a current to flow and this will result in the metal surface being attacked.

Originally it was thought that with some reactions, for example the solution of zinc in sulphuric acid, the action was a purely chemical one and that no electric current was involved. Experimental work, however, has shown that this is not so. If very pure zinc as near free from impurities as it is possible to get, is placed in extremely pure acid and all air removed from the system, the zinc will not be attacked. Under these circumstances the current produced in the surface layer of the zinc is negligible and the attack therefore is extremely small. With a normal commercial product, however, there are sufficient impurities producing different potentials at different points on the surface and local currents are formed which allow the zinc to be attacked by the acid. In this case the zinc will enter the solution as zinc ions and the hydrogen ions from the acid will be discharged at the surface of the metal to produce hydrogen gas. When a sheet of metal is immersed in a solution of metal salts an electric potential will be set up between the solution and the metal. This may be regarded as a measure of the tendency of the metal to go into the solution, or the metal ion to deposit out on to the surface as the case may be. It can be imagined that a few of the metal atoms on the surface of the metal will leave the surface and enter the solution in the form of ions. This will mean that there will be an extra number of electrons on the metal surface and if these cannot get away they will then tend to attract back the metal ions to the surface again. Finally a balance will be struck when no more metal atoms can leave the surface and this will result in a potential being set up between the surface and the solution due to an increased number of electrons on the surface. These potentials may be measured and are specific for various metals and also vary with the concentration of the metal ion in the solution. (*To be continued*)

Adsorbtion of Cyanide on weakly basic Anion Exchange.

(*Continued from page* 431)

solution were then passed through the resin layer. After washing with 50 ml. distilled water the combined effluent and wash water were titrated with 0.1 N. $AgNO_3$. In this case 14.0 ml. were consumed, *i.e.* the free cyanide content was larger than before the ion-exchange passage. Obviously the complex cuprous cyan e i ons at the adsorption on the resin (no copper co:ld be detected in the effluent) had desorbed part of the cyanide ions previously adsorbed.

From the experiments described in this paper it is concluded that it is not possible to determine the free cyanide content of cyanide-copper plating solutions through adsorbing the complex copper cyanide ions on a weakly basic anion exchanger, as a fraction of the cyanide ions are adsorbed.

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INTERNATIONAL SCHOOL OF GRINDING

THE first international school of grinding sponsored by Norton International Inc. and staged by Norton Grinding Wheel Co. Ltd. has recently been held at Welwyn Garden City, Herts, The purpose of the Training School was to acquaint sales personnel with the latest grinding techniques and familiarize them with Norton abrasive product lines. This first course was followed by two similar sessions. The first class was primarily for English speaking trainees, the second for French and Italian speaking nationals, and the last for German speaking nationals.

Norton International Inc. plans to follow this school with further training programmes to help its distributors—more than 100—and selected personnel from the Company's 15 foreign manufacturing plants.

The EFFLUENT and WATER-TREATMENT Exhibition

A REVIEW OF SOME EQUIPMENT ON SHOW

THE first Effluent and Water Treatment Exhibition and Convention was held at the Seymour Hall, London from October 18 to 21. Thirty three firms were exhibiting and although small by modern exhibition standards the nature of the hall and layout of the stands imparted a more intimate and friendly atmosphere to the numerous technical discussions that ensued between stand personnel and the many visitors. The Convention was also very well attended and delegates were registered from numerous overseas countries to hear the thirteen papers and see the two films. Here is a brief resume of some of the equipment that was on show:

Albright and Wilson (Mfg.) Ltd.

1 Knightsbridge Green, London, S.W.1

A working model of a condenser cell, kindly loaned by the director, National Engineering Laboratory (DSIR), was the main feature of the stand. It was used to demonstrate the ability of Hagafilm, a filming amine, new to this country, to promote drop-wise condensation of steam. Great emphasis was laid upon it for use in space heaters, process heaters, evaporators and condensate lines.

The complete range of chemicals available from the company were on show with Calgon being recommended for threshold treatment in water heating and cooling systems and for the smaller installations, Micromet. For the prevention of scale deposits in high and low pressure boilers the use of phosphate conditioning was shown as one of the most effective systems, while for descaling cooling systems, small boilers and heat exchangers, Calgon descaler was recommended. This contains inhibitors which make it safe in contact with almost all metals, and also a built-in colour indicator to show when it is exhausted.

Chemical Engineering Construction (Pensett) Ltd.

Montfort House, 168 Lower High Street, Stourbridge

The company's exhibits were divided into five sections :

Effluent Neutralizing Plant. The treatment of trade waste from the metal-finishing industry was illustrated with photographs of one of the largest plants in the country that they have recently built for Wilmot Breeden Ltd., Tyseley. The treatment of trade wastes from the pickling of steel and non-ferrous metals are another feature of the company's activities and plants are in operation at Richard Thomas and Baldwins and the Citroen Motor Car Co. in France.

Acid Regeneration. A demonstration of the recovery of sulphuric acid from continuous steel pickling plant by the cooling of the spent liquors to precipitate ferrous sulphate crystals and re-circulating the regenerated acids.

Oil Cracking. There was pictorial illustration of the treatment of water-soluble waste rolling oil from a mill, by separation with acid, the cracked oil being stored for collection by road tanker and the acid liquor passing to an effluent neutralizing plant.

Materials of Construction. On show were examples of rubber and brick lining of steel and concrete tanks, demonstrating the use of acid-resisting Accrington red and Staffordshire blue bricks, also carbon block lining, for resistance to nitric and hydrofluoric acid. There were also other examples of various chemical resisting tank linings, and a new type of hose coupling was demonstrated.

The company are suppliers of *p*H controllers, flow recorders, sulphonators for the treatment of chrome and chlorinators for the treatment of cyanide.

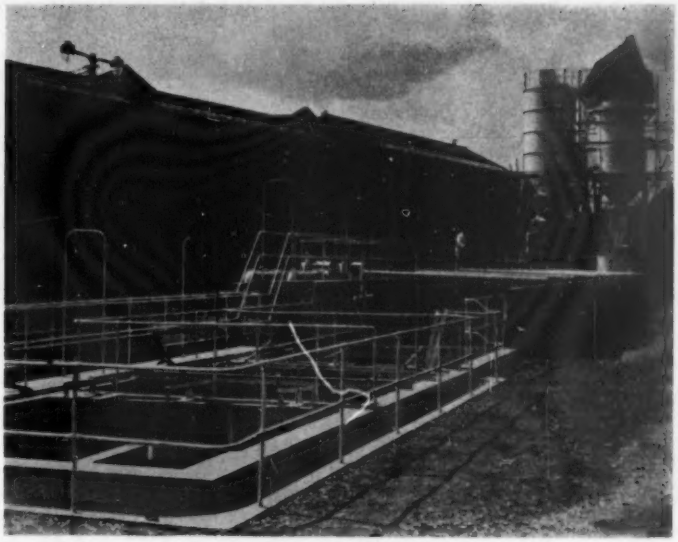


Fig. 1.—A plant installed by Chemical Engineering Construction (Pensett) Ltd. at Wilmot Breedon Ltd., Tyseley, Birmingham for the combined treatment of 36,000 gallons per hour of mixed electroplating effluent. It consists of reservoir, reaction tanks, settling tanks and filtration plant for ultimate recovery and recirculation. Storage silos and measuring vessels can be seen in the background.

Electronic Instruments Ltd.

Richmond, Surrey

The company were showing a new range of colorimetric analyzers for the analysis of process and boiler feed water, claimed to be the most accurate and foremost in the world for industrial, marine and commercial use.

The Hydrazine Analyzer, Model 60A measures the quantity of hydrazine (0 to 0.5 p.p.m.) in boiler feed water. Hydrazine is added to demineralized water to remove the dissolved oxygen that would otherwise cause corrosion in boiler installations. It is desirable to maintain only a slight excess of hydrazine and it is this excess which is measured with this instrument.

The Phosphate Analyzer, Model 59A monitors and thereby controls the quantity of phosphate fed into boiler feed water to soften it and prevent the formation of scale in boilers. Phosphate concentrations up to 60 p.p.m. can be measured and recorded by this instrument eliminating the necessity for periodic manual determinations in the laboratory.

The Turbidity Analyzer, Model 61A is used for monitoring the turbidity or colour of various process waters and effluents.

pH Equipment. Seven different types of meters and electrode systems for nearly every conceivable application were on show together with many other accessories.

Evershed and Vignoles Ltd.

Acton Lane Works, Chiswick, London, W.4

Evershed and Vignoles Ltd. demonstrated two ranges of instruments for analyzing and determining impurities in solution. These were the range of "Dionic" conductivity measuring instruments and Tinsley polarographs.

The polarographic method of analysis is particularly suitable for the analysis of small amounts of material in solution, and the analysis of effluent types of liquid. In many instances it will be possible to effect the analysis with a minimum of chemical processing and to arrange the system so that measurements may be made with a flowing solution. Where an effluent has to be controlled and a large number of related analyses have to be performed frequently, the polarographic method enables the analyst to delegate the task to semi-skilled assistants once the method is established. This form of practical application of polarography to routine problems is made easier with the Tinsley recording polarograph.

These techniques may also be used for qualitative and quantitative measurements of impurities in various solutions with particular reference to sewage or industrial effluents, or alternatively, the measurement of the overall purity of water for drinking or industrial use. Measurements of overall pollution may be linked to the available oxygen. In this method polarography represents an elegant and sensitive method which has already been adopted to form part of a continuous flow circuit. It is also possible, for example, to distinguish Cu, Cr, Cd, Zn and Ni in a single sample, and to determine quantitatively Cd, Zn, Ni and Cu together, assuming no chromium to be present. Organic materials used in the manufacture of plastics may also be measured in waste. For

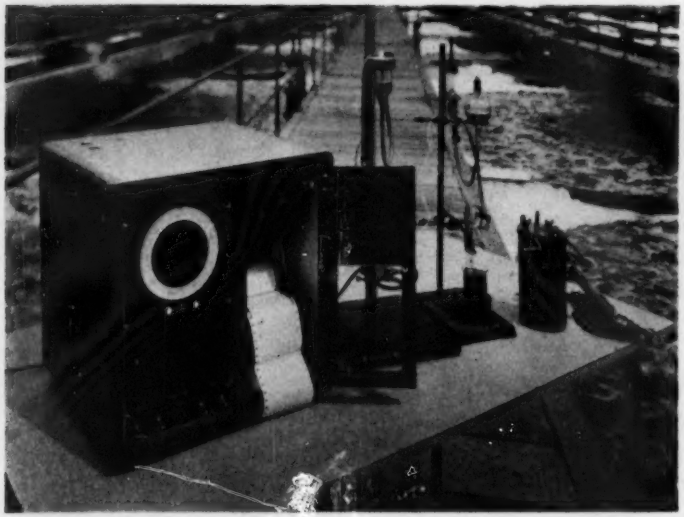


Fig. 2. — The Tinsley recording polarograph, manufactured by Evershed and Vignoles Ltd., being used to determine the impurities in sewage effluent at the Oxford Corporation Sewage Disposal Works, Sandford-on-Thames.

example the determination of acrylonitrile (vinyl cyanide) has been developed on a continuous basis by polarographic methods.

The Tinsley polarographs shown included the latest indicating and recording model which has exceptional sensitivity and is particularly suitable for operation by semi-skilled staff. In addition, various advanced types of electrodes and ancillary equipment, for example, a thermostatic bath and a range of special glassware, were demonstrated.

Indicating and recording conductivity meters and portable instruments were shown, and particular attention was drawn to the recently introduced pipe-type " Dionic " conductivity cell.

The pipe-type " Dionic " conductivity cell makes it unnecessary to withdraw a sample of the solution to be tested and offers particular advantages where the solution to be tested is in short supply and wastage has to be avoided. Furthermore the installation of this unit requires no auxiliary pipe work and can be fitted to existing pipe systems. The cell embodies automatic temperature compensation in the range of 60°F. and 200°F., and is suitable for operation at pressures up to 200 lb. per sq. in. In view of the " continuous " mode of operation of the cell, it has been provided with a bronze gate valve so arranged that the electrode unit may be withdrawn for cleaning or inspection without the need for a " shut down " of the plant.

A typical application for the new conductivity cell is the control of the concentration of a mixture on the basis of conductivity measurements. For this purpose the pipe-type conductivity cell is arranged to generate an electrical signal representing the " measured value " signal for a process controller, the output of which is used to adjust the speed of a pump in order to control the mixing ratio of two liquids. The concentration of each may be kept at a constant value by this method.

Other typical applications for the range of Evershed conductivity measuring instruments embrace, in connection with simple " on/off " controllers, the control of salinity of estuarine water or the concentration of alkali or detergent in wash liquor, while more complex systems have been used in the sugar industry.

Conductivity meters are also used in evaporators to detect priming, or condenser tube leakage and in ion-exchange plants to detect break-through through the ion-exchange resin.

Freeman, Taylor Machines Ltd.

Necton Street Works, Syston, Nr. Leicester

A new system of heat recovery, assembled from a range of fully interchangeable components, has been designed by the company. This plant, known as the Caloreff is claimed to achieve maximum rates of heat transfer under a variety of operating conditions. It is offered as a complete plant and is able to accept waste and heated effluent, however corrosive from any number of points, recover a large percentage of the contained heat and discharge cooled effluent at a temperature usually suitable for the appropriate drains. In the standard range of components the principle material is En.58.J type stainless steel although high-impact P.V.C. piping is used wherever temperature permits. Other materials are possible depending on the effluent to be handled.

The plant is designed to handle intermittent flow conditions with pumping action being automatically controlled. The heat exchange is effected

by shell and tube heat exchangers. One basic size is used, applied in either series or parallel, dependent upon temperatures and rates of flow. This enables maintenance to be carried out with a minimum of inconvenience, one spare unit being all that is required to ensure uninterrupted flow lines. Changes in process conditions can also be efficiently handled since addition to, or subtraction from, a bank of exchangers is easily carried out with predictable results.

An automatic reversing time cycle controller, the Autorev, was also to be seen working on this stand. Although its prime function when designed was to control electrical gear for flow reversals, its applications have proved to be very broad. It is capable of operating existing electrical contactors, whether electrically or mechanically interlocked and can work by manual or automatic control. A preset delay is normally introduced between reversals.

Head Wrightson Processes Ltd.

20/24 Old Street, London, E.C.1

The activities of the Head Wrightson group of companies are centred on the supply of equipment for those heavy industries which are concerned with the extraction of mineral and metal ores and oil from the earth, the processing of coal, ferrous and non-ferrous metals, the refining of oil and the production of equipment and components for all forms of transport on land and sea and in the air. More recently the company have pioneered the design and manufacture of nuclear research and power plant and are handling several overseas contracts for research reactors.

So far as water treatment plants are concerned, they have an agreement with the Belco Industrial Equipment Division of Paterson, New Jersey, which enables them to offer the water treatment processes developed by the American concern.

On their stand they had on display their heating, cooling and water treatment equipment and the central feature of the stand was a working model of a filtration plant.

George Kent Ltd.

Biscot Road Works, Luton, Bedfordshire

Among the exhibits were several items only recently announced by the company, one of which was the variable duration impulse transmission system in which the ratio of "on-off" time of a cyclicly repeating electric current in the transmitting circuit is made to vary proportionately with the signal to be transmitted. Designed for use in the company's already extensive range of uniformly styled measuring instruments, this V.D.I. system provides a flexible, efficient yet inexpensive additional system of telemetering.

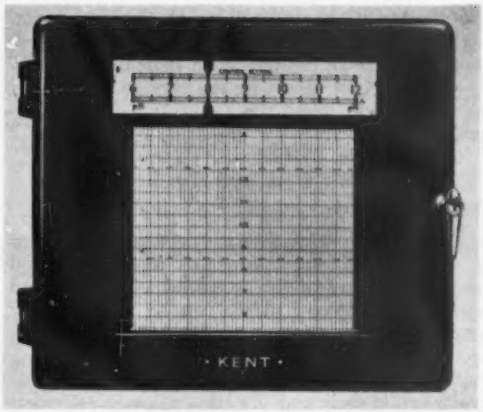


Fig. 3.—A Multelec Mk. 2, Universal pH controller made by George Kent Ltd., fitted with a Mk. 20 air-operated automatic control.

Other recent instrument additions included in the display were the linear-scale Commander KF model for the measurement of open-channel flows and the bellows operated KB model for measuring static pressure or liquid level. The bellows module may be used either as the primary measuring element or as an additional measuring element in other Commander models such as those for flow.

From the variety of mechanical and electronic Multelec instruments now available was a Mark 2 *p*H recorder/controller, a Mark 2 telerecorder receiver with integrator and a 16-point Mark 3 high-speed electronic recorder employing a new Zener-diode constant-voltage source.

Also on show was the JSM pipe-line domestic water meter, operating on the semi-positive rotary-piston principle ; a typical high-discharge rate Master industrial water meter ; a Commander KU mercurial flow recorder/controller ; Dall flow tube and Dall flow orifice low-head-loss pressure-difference devices and a unit enabling the relative head losses of various p.d. devices to be conveniently compared.

Charles Lennig and Co. (Great Britain) Ltd.

26-28 Bedford Row, London, W.C.1

The company's exhibit consisted of a detailed display of Amberlite ion-exchange resins, emphasizing their properties and uses, with samples of all the commercially available grades on hand for visual inspection.

Part of the display included an interesting graphical sketch of the achievements in ion-exchange technology over the past years with reference to the latest Rohm and Haas development of highly stable ion-exchange material.

The first Amberlite in this new category of ion-exchange resins, Amberlite 200 was introduced

and explained by technicians at the stand and generally the series was of great interest to those attending the convention since increased stability allows them to be used with the aggressive solutions that up to now make the conventional resins decrosslink.

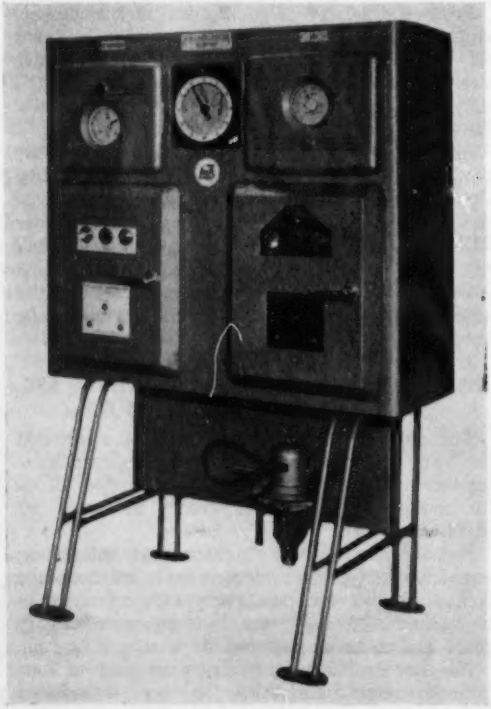
A. M. Lock and Co. Ltd.

Prudential Buildings, 79 Union Street, Oldham, Lancs

The company were showing representative items of particular interest for the monitoring and automatic control of the treatment of effluent and trade wastes, among which was an automatically controlled treatment system for the detoxication and neutralization of cyanide and chromium-bearing trade wastes from galvanizing, plating and heat-treatment plants, and for the *p*H neutralization of effluents prior to discharge into rivers or sewers.

The waste water is automatically adjusted to the required *p*H value, and is then passed through a rapid reaction tank of special design, into which the appropriate reagent (SO_2 Cl_2 etc.) is added under automatic control, The state of the reaction in the continuous-flow reaction tank is monitored by an electro-chemical detector which is connected to an electronic amplifier and reaction controller. This regulates the gas addition device or controls a liquid reagent valve adding, for example, sodium hypochlorite.

Fig. 4.—Typical Lock effluent control panel.



Another interesting exhibit, in the field of level indicators and controls, was the Simcar radiation switch. The switch is designed to operate when radiation begins or ceases to fall on it. The source of radiation is normally a small amount of cobalt 60 or caesium 137 in a lead container. For certain applications it can simply be a patch of radioactive paint of low activity.

The design normally exploits the principle that if material between the switch and the source is replaced with a material of greater or lesser density, there will be a correspondingly higher or lower degree of radiation absorption. The beam of radiation from the sources will either be prevented from reaching the switch, or will be allowed to reach it. This is the principle involved in such applications as level control.

In one application the switch is arranged to operate when the beam of radiation and the switch come into alignment. This method of operation is applied to the indication or control of objects in relative motion. For example, the switch can be employed very effectively for the control of mine skips, which must be stopped very precisely at the upper limit of the hoist and aligned correctly with the tipping platform. The switch is able to position the skip with a margin of accuracy of $\frac{1}{4}$ in.

The switch and associated apparatus are designed in accordance with the generally accepted principle that the application of radiation in industry at large should not burden workers with the necessity of wearing protective clothing, undergoing periodical medical examinations and observing special procedures.

Also on show was the Lock portable, fully transistorized conductivity bridge and the mains-operated laboratory conductivity bridge.

Neckar Water Softener Co. Ltd.

Artillery House, Artillery Row, London, S.W.1

The main attraction on the company's stand was centred around a model of a mono-bed or mixed bed unit. The model demonstrated the arrangement of this deionization plant, in which the method of recovering both cations and anions from water enables water of very high chemical purity to be produced. The technique involves the passage of the fluid through an intimate mixture of a cation exchanger, in the hydrogen form and an anion exchanger, in the hydroxyl form.

Also on show was the Neckar hardness detector. This unit makes regular automatic hardness tests to make sure that the water remains fully softened. It is arranged in such a way that a small volume of

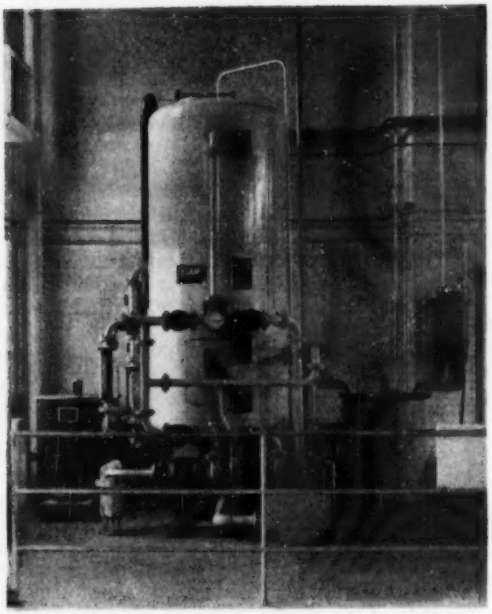


Fig. 5.—Neckar mono-bed de-ionization plant.

softened water is continuously bled from the base exchange unit to a constant head tank, from which the hardness tester takes its samples.

Prodorite Ltd.

Eagle Works, Wednesbury, Staffs

This company, apart from offering a complete service to industry which includes the design, installation and commissioning of effluent treatment plants are also responsible for chemical engineering and acid-proof constructions of all types including tanks, floors and drainage embodying a range of corrosion resistant mastics, compounds and a new and improved range of cements, manufactured in this country by Prodorite under special licence from Farbwerke Hoechst AG.

The plastic fabrications and piping installations in P.V.C. and polythene were supplemented at the exhibition by a range of resin/glass laminate materials with the trade name Orglas. These materials are resistant to practically all oxidizing and non-oxidizing acids, alkalis and solvents up to temperatures of 120°C. ; Orglas Y50 is available for temperatures up to 160°C.

Surface coatings provided the major exhibit showing 30-in. diameter steel pipes lined with Prodor film for submarine pipelines, examples of Prodor Glas and Prodor cote synthetic linings and coatings for protection against crude oils, petroleum, diesel and high octane fuels, while liquid and sheet neoprene coatings and linings, providing complete anti-corrosive, anti-abrasive and weather proofing protection for a wide range of plant and equipment, were also on show.

Saunders Valve Co. Ltd.

Grange Road, Cwmbran, Monmouthshire

The growing demand for completely automatic water treatment plants has directed attention to remote controlled valves and accordingly the exhibit of the company placed particular emphasis on their latest designs for these units. Among the new developments on show were a rubber-lined non-return valve and a solid P.T.F.E. valve, both of which are suitable for chemical dosing and effluent treatment.

Since many effluents are severely corrosive, suitably lined valves are required and a selection of the wide range of lined valves available from the company was on show, illustrating the use of rubbers such as neoprene and ebonite, metals such as lead or titanium and plastics such as nylon and polythene.

Products of the Safran pump division could also be seen and a working model of a Safran self-contained electric motor-driven pump was of particular interest.

Southern Instruments Ltd.

Frimley Road, Camberley, Surrey

The company's stand had several important pieces of equipment on show of which the following were of special note :

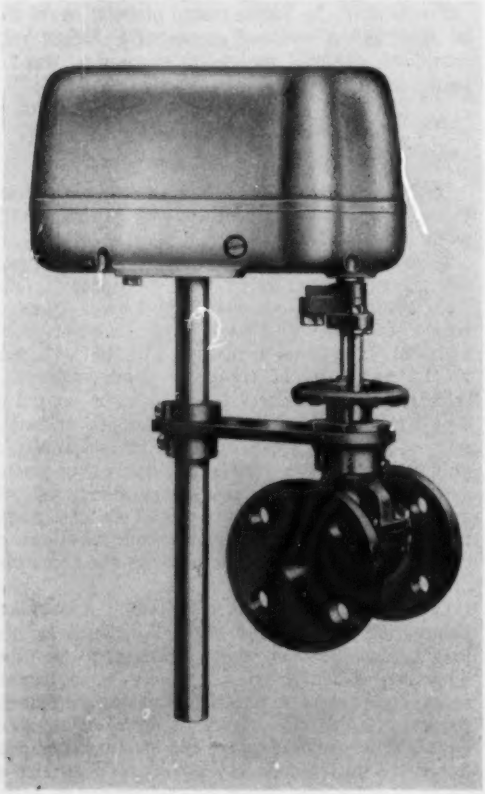
Manual Polarograph (A1650). This compact instrument is extremely easy to operate. The " click-stop " method of voltage control in increments of 100 mV or 10 mV gives this polarograph a speed of operation comparable to recording polarographs and a complete polarogram of a solution, containing several ions, can be plotted in 3 or 4 minutes. In routine analysis this operation may only take a few seconds. The sensitivity is only limited by the sensitivity of the galvanometer and the one supplied has a sensitivity of 100 mm. of scale for 1μA, which allows the determination of most metallic ions in concentrations of p.p.m. It is also ideal for teaching the principles of polarography.

Cathode Ray Polarograph (K1000). A complete polarogram is presented every 7 seconds on the long persistence 9 cm. screen of a cathode-ray tube. This can either be viewed direct, or a camera attachment can be supplied for making permanent records. Unlike the waves or steps obtained in conventional polarography, the polarograms produced by the cathode ray polarograph consist of

peaks, the heights of which are proportional to concentration. The height of a peak can be measured more easily and more quickly than in conventional methods. The discrimination is also superior and elements as close together as 0.1 v on the polarographic "spectrum" can be determined. With the derivative circuit, peaks differing by as little as 0.05 v can be measured. The peaked nature of the waves allows greater sensitivity and the determination of 1 part in 100 million is possible.

Dissolved Oxygen Apparatus. This has been designed, following development by the Water Pollution Research Laboratory at Stevenage, for the rapid determination of dissolved oxygen in stationary samples of river waters and effluents over a range of 0 to 15 p.p.m. with an accuracy better than 0.1 p.p.m. The apparatus is portable and completely self contained so that tests can be carried out *in situ* if desired. It is robust and simple to operate and a determination can be made in less than a minute by unskilled personnel.

Fig. 6.—Saunders diaphragm valve with Rotork actuator type 1F for valve sizes ½in. to 2in. Normal supply 230 volts, single-phase, 50 cycles.



Hydrogen Generator (A1653). This apparatus consists of a d.c. supply and a special electrolytic cell in one compact unit. It is mainly for use in polarography for deoxygenating solutions prior to polarographic analysis.

It eliminates the inconvenience of transporting and replenishing cumbersome gas cylinders and the difficulty of controlling small quantities of gas. A rotary switch enables hydrogen to be generated at four different rates of flow up to 3500 cc/hour and 5 to 10 ml. of solution can be deoxygenated in 3 to 5 minutes.

"*Nilox*" *Apparatus* (A1659). This enables the laboratory worker to obtain a continuous stream of hydrogen, nitrogen, argon, etc., completely free of the oxygen normally contaminating these gases as supplied in cylinders. It consists of a special scrubber designed for highly efficient gas-liquid exchange. The primary absorbent is a chromium salt which is oxidized, but is reduced back by contact with a zinc amalgam in the same scrubber. For gases highly contaminated with oxygen, a pre-purifier is supplied, which removes the bulk of the oxygen while the scrubber finishes off the purification.

The Sigrist Photometer. For the continuous recording of absorption and turbidity. Two beams from the same light source are directed by means of an oscillating mirror alternately to the same photocell. The measuring beam passes through the test fluid and the other beam through a comparison standard. Fluctuation of the light source, variable sensitivity of the photocell and rate of amplification of photo current do not affect accuracy of measurements. Several models are available for the laboratory and also for the automatic control of industrial plant.

Simon-Carves Ltd. and Monsanto Chemicals Ltd.

Cheadle Heath, Stockport, Cheshire

Simon-Carves Ltd. and Monsanto Chemicals Ltd. have polled their scientific knowledge and research in order to offer to industry and public authorities a comprehensive advisory service on the treatment and harmless disposal of trade wastes.

Both companies have wide experience in this field. Simon-Carves Ltd., as engineering designers and contractors to the coal carbonizing and chemical industries, deal with the effluent problems of their clients, while Monsanto Chemicals Ltd., as chemical manufacturers, have successfully developed biological purification processes and have operated for many years a major puri-

(*continued in page* 449)

Effluent and Water Treatment Exhibition

(*continued from page* 448)

fication plant at their Ruabon factory in North Wales.

This joint advisory service provides :

(a) on-site and laboratory investigation of effluent problems ;
(b) recommendations for suitable treatment, and design data for treatment plants ;
(c) continuing advisory service, if required, on the operation of installed plant.

The service is administered from Cheadle Heath, Stockport by Simon-Carves Ltd., who in addition undertake the design, construction and commissioning of complete effluent treatment plants, or the technical supervision of this work if done by other contractors.

The Tintometer Ltd.

Waterloo Road, Salisbury

The Lovibond comparator and the B.D.H. Lovibond nesslerizer are used for the control of the purity of all types of water. The manufacturers of this equipment were exhibiting a range of Lovibond comparator kits specially designed for testing water in swimming pools, rivers, effluents, boiler feed and drinking water. The B.D.H. nesslerizer was also on show together with a range of discs of permanent glass colour standards which are widely known and used in water laboratories throughout the world.

Of particular interest to chemists and also those responsible for routine analysis was a book entitled " Colorimetric Chemical Analytical Methods " which was available on the stand for inspection. This book, containing full procedures for well over 160 analytical tests is a complete guide to well tried and reliable colorimetric analytical tests.

Some of the tests for which permanent glass colour standards are available for use in the comparator and nesslerizer are, aluminium, ammonia, chlorine (range from 0.01 to 250 p.p.m.) copper, iron, lead, manganese, nitrate, nitrite, oxygen, *p*H (range from 0.2 to 14.0) and phosphate.

Tough Plastics Ltd.

Byfleet Road, Addlestone, Surrey

This company specialize in industrially fabricated plastics and corrosion resistant plant of all types. Their exhibit was typical of the type of work carried out by them and illustrated a fabrication suitable for a water treatment plant.

The tank shown in Tufplas, a bonded combination of unplasticized P.V.C. and best quality polyester resin reinforced with glass fibre, is a smaller version of storage tanks being used in industry for deionized and demineralit water. This type of construction allows the unplasticized P.V.C. to be used at temperatures up to 100°C. and ensures a physically strong vessel. A cross-linked isocyanate polyester resin final coat is applied to all fabrications for maximum external corrosion resistance and weathering protection.

The company also stock and distribute solely in the U.K. a wide range of moulded nylon, polypropylene and polythene taps, cocks and laboratory fittings and arranges distribution throughout the laboratory furnishing companies.

SELECTIVE PLATING

Some Details of Process available in the U.S.A.

AVAILABLE in the U.S.A. is the " Selectron " process for selective plating, in which special styli and a power pack are used to apply a wide range of base and precious metal coatings to metals in large or small areas. All the plating solutions are metallo-organic and it is claimed that they do not harm the skin nor give off noxious fumes. The high-metal content of the solutions, it is said, gives very short plating times, *e.g.* to deposit 0.001 in. copper 60 sec., 0.001 in. tin, 10 sec., 0.001 in. nickel, 120 sec., etc. The styli fit easily in the hand and are cooled either by cooling fins or by water cooling on the larger units. A lead from the power pack plugs in one end of a stylus and a replaceable carbon rod anode in the other. The electrolyte is contained in a saturated pad.

It is claimed that areas plated by this process will withstand any of the standard tests for adhesion and that the corrosion resistance is also equal to bath-plated deposits. In general the deposit is harder and denser than conventional plating, it is said to be completely crack-free with an exceptional low porosity, and to have no measurable hydrogen embrittlement.

The power pack used with the process includes an accurate ampere-hour meter, and the thickness can be controlled to within 10 per cent. Typical applications of the process are tin-lead plating of Al. alloys prior to soldering, repair of electrical contacts by gold, or rhodium plating, building-up shafts, bearings, etc., touch-up plating, stopping-off for carburizing, nitriding, etc., repairing breaks in printed circuits, plating on cylindrical components while parts rotate in lathe, plating on jewellery, repair of gravure plates, etc.

Further information on this plating process, which has been approved by numerous U.S. Government agencies for specification work, may be obtained from Selectrons Ltd., 520, Fifth Avenue, New York 36, N.Y., U.S.A.

I'm afraid it's all silver

No call to apologise! Indeed the best conductors *are* silver . . . and the brighter the better. The new PLUSBRITE Silver addition agents provide the fastest silver plating process and the brightest finish for electrical contacts. With PLUSBRITE Silver the deposit of metal is unalloyed and retains its full electrical conductivity. PLUSBRITE Silver addition agents assist in forming an exceptionally hard deposit of bright silver, which notably resists tarnish. They are finding use also in a wide range of silver-plated products. Mechanical finishing can often be eliminated.

Plusbrite

ADDITION AGENTS

For technical information or service ring or write to:
ALBRIGHT & WILSON (MFG) LTD
METAL FINISHING DEPARTMENT
1 KNIGHTSBRIDGE GREEN
LONDON · SW1
Telephone: Kensington 3422

FINISHING

NEWS REVIEW

VITREOUS-ENAMELLED ALUMINIUM IN ARCHITECTURE

ONE of the latest and most interesting developments in the vitreous enamel industry is the enamelling of aluminium. During the past two years this process has become established commercially in Great Britain and a considerable growth in the use of vitreous-enamelled aluminium, particularly in architecture, is foreseen in the future. As part of its programme in promoting the use of vitreous enamel and maintaining high standards for the industry, the Vitreous Enamel Development Council has published a tentative commercial specification for vitreous-enamelled aluminium for architectural applications. This follows up the V.E.D.C.'s recommended standards and general specification for vitreous enamel now included in the brochure "Vitreous Enamel in Architecture."

As aluminium melts at 650°C., which is lower than the firing temperature of steel enamels, new frits have been developed, thus making possible the enamelling of aluminium.

Vitreous-enamelled panels have been used on buildings in the United States for over 10 years. During 1957, 5,000,000 sq. ft. of aluminium was coated with vitreous enamel, and the figure forecast for 1961 is in the region of 23,000,000 sq. ft.

In this country practical applications of vitreous-enamelled aluminium are starting to appear. The main use is in architecture, internal as well as external, for curtain wall infill panels, partition panels, wall tiles and decorative trim. It is, however, also very suitable for other uses, such as road and advertising signs and domestic appliances. Vitreous-enamelled aluminium hollow-ware is already on the market.

Vitreous enamel enhances the good features of aluminium; it adds colour in an almost unlimited range, maintains its original appearance over long periods and is simple to clean. It is also light and easy to handle and can be sheared or cut with practically no serration of the edges.

The new automatic shot-blasting cabinet at West's Loyne Ltd., Miles Platting, Manchester, which will accommodate work up to 30 ft. by 12 ft. by 12 ft.

New Service for Protective Coatings on Heavy Equipment

A NEW service for the application of a comprehensive range of anti-corrosion and protective coatings to heavy equipment up to 5 tons in weight has been established at the works of West's-Loyne Ltd., Norton Street, Miles Platting, Manchester, by the installation of specialized plant, which includes one of the largest fully-automatic shot-blasting cabinets installed in Britain for this kind of work, and a large gas-fired oven for the sintering and stoving of coatings or the heat-treatment of metals. The installation is complete with up-to-date preparation and coating equipment and the necessary cranes for moving large items while under treatment.

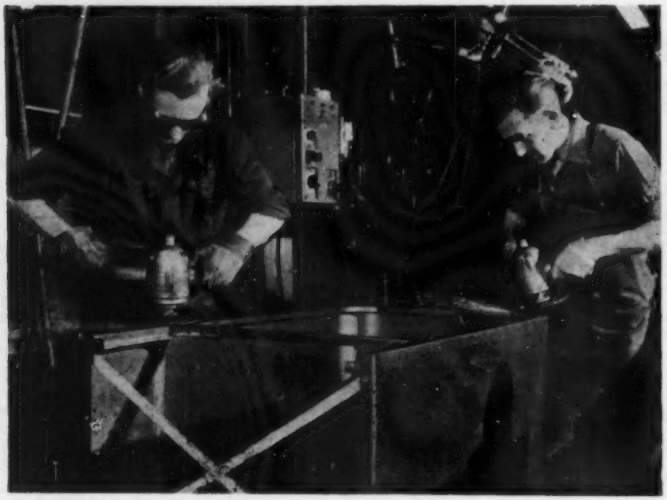
Among the coatings applied are epoxy resins for the linings of vessels containing food, oil or chemicals, phenolics (water and acid resistant), synthetic rubber for abrasion resistance and corrosion prevention, P.T.F.E., P.T.F.C.E. for insulation and resistance to high temperature and corrosive gases and acids, silicones, metal spraying (zinc, aluminium and stainless-steel), and flame spraying (polythene, nylon, P.V.C.).

The gas-fired oven is 30 ft. long, 12 ft. wide and 10 ft. high is designed for sintering P.T.F.E. and P.T.F.C.E. and for stoving high-bake epoxy, phenolic and silicone coatings. A temperature of 450°C. can be attained when needed for heat-treatment of metal if required before P.T.F.E. coating. Provision is also made for curing coatings by hot air and infra-red heaters. Other facilities available at the plant include equipment for shot-blasting very large vessels in the open with mineral grit and preparation by flame-cleaning and power wire-brushing. Both powder

(*Continued in page* 458)

AIR TOOLS PREPARE REFRIGERATORS FOR PAINTING

AT their Luton works, Electrolux Ltd. produce nine domestic refrigerator models for home and export sale, and use the Ransburg electrostatic spraying process for both priming and finishing coats. In this process, which at the Electrolux factory is fully mechanized, paint carrying a positive electrical charge is attracted to the negatively charged metal cabinets, which are earthed through the jigs on which they traverse the paint spray booths.



One characteristic of the Ransburg method is that it does not hide any blemishes on a metal surface. For this reason every mark on the refrigerator cabinets, together with the excess metal resulting from brazing and spot welding, has to be removed. Before passing through the paint spraying booths, the cabinets are carried by roller and floor conveyors to a surface preparation shop, where all blemishes are removed with the aid of pneumatic surface grinders. For initial cleaning up, No. 36 or No. 60 resin-bonded abrasive discs are employed, finishing touches being made with No. 80 or No. 100 discs.

The surface grinders used in quantity by Electrolux Ltd. are Atlas Copco LSS 62 R60's. These machines operate at a speed of 6,000 r.p.m. and take a ¼-in. hose. Height including spindle is 8 in. and weight is just over 8 lbs.

After surface preparation is complete, the cabinets are painted, stoved and then inspected under strip lighting. Any cabinet which fails to meet the high standard of finish is returned to the surface preparation bays for further attention, whence it must traverse the whole finishing line again.

VENESTA ACQUIRE INTEREST IN ACORN

THE directors of Venesta Ltd. recently announced that they had acquired an 80 per cent interest in Acorn Anodizing Co. Ltd., leading jobbing anodizers and metal finishers in London and Birmingham. Acorn Anodising Co. Ltd. will continue their present activities and will also co-operate with two other subsidiaries of Venesta Ltd., namely Venesta Plywood Ltd. and Venesta Metal Containers Ltd. in the development of projects which are complementary to these companies.

The management of Acorn Anodising Co. Ltd. remains unchanged.

SCHOLARSHIP

FOLLOWING the recent announcement of the setting up of a scholarship scheme administered jointly by Constructors John Brown Ltd. and the Institution of Chemical Engineers, a research scholarship has now been awarded to Mr. M. D. Taylor of the Department of Chemical Engineering, King's College, University of Durham, to the value of £450 per annum, for two years in the first instance. The purpose of the scholarship is to encourage research in chemical engineering and, in particular, in chemical plant design.

INDUSTRIAL FINISHES CONVENTION FOR 1961

THE announcement that the first International Finishes Exhibition will be held at Earls Court, London, between May 8 and 11, 1961, has resulted in a large proportion of the available floor space being already booked by a number of leading firms interested in the processes involved. The organizers (Scientific Surveys Ltd., Exhibition Division, 97, Old Brompton Road, London, S.W.7) are arranging to hold an Industrial Finishes Convention at the same time as the exhibition in the special meeting rooms at Earls Court. The convention will consist of two sessions daily ; preprints of papers will be available to convention delegates who will be invited to participate in the discussions, which will be presided over by chairmen expert in the subject matter of the session. Proposals for suggested papers and speakers are now being examined.

ELECTRO-PLATING AND POLISHING IN AUSTRALIA

TO meet the growing demand in Australia for electroplating and polishing plant, W. Canning and Co. Ltd. have purchased a direct interest in the firm of Lawrence Smith and Co. (Pty.) Ltd. who have represented Canning interests in Australia for more than fifty years, and will now operate in future as Lawrence Smith and Canning (Pty.) Ltd. Branches have been opened in Melbourne, and Brisbane and further arrangements will be made in Adelaide. Several automatic plating and polishing plants have already been supplied to Australia, the latest of which is to N.V. Appleton (Pty.) Ltd. of Brisbane, which takes jigs 8 ft. 6 in. wide by 3 ft. deep and is for the zinc plating of window louvres.

FIRST AID IN FACTORIES

THE First-aid (Miscellaneous Industries) Order, 1960, S.I.1960, No. 1961, published by H.M. Stationary Office, price 3d. net, specifies the industries and processes in which waterproof adhesive wound dressings and waterproof adhesive plasters have to be provided in first-aid boxes or cupboards. These items, which are an addition to the first-aid requisites which have to be provided in factories generally, are to protect workers with open cuts against wet or acid processes. The processes listed in the schedule include chromium plating and chemical processes.

FERRO-ENAMELS CELEBRATE TWENTY-FIFTH ANNIVERSARY

FERRO Enamels Ltd., Wombourn, Wolverhampton, recently celebrated having completed its first twenty-five years of manufacturing operations, during which period its annual capacity has increased from 1¼ million pounds of enamel frit to its present capacity of 20 million pounds, and the company has gained a reputation for high-quality vitreous-enamel goods known throughout the world. In referring to this achievement, Mr. S. W. Vickery, the chairman and managing director, paid tribute to Mr. Robert A. Weaver, founder and chairman of the Ferro Corporation of Cleveland, Ohio, U.S.A., the parent company, whose vision and initiative made the Ferro corporate enterprise possible; he also referred in the same vein to all those in whatever capacity who have contributed to the growth of Ferro during the last 25 years. While the primary function of Ferro Enamels is the production of vitreous enamels, a venture in which chemists and technicians are constantly employed in developing improvements both in materials and colour, the company's engineering services co-

Mr. S. W. Vickery
(Chairman and Managing Director Ferro Enamels Ltd.)

operate to serve customers in Britain, Europe, Africa and the Near East and have installed a high percentage of all the continuous furnaces in use today. On the educational side the company organized the first refresher course in 1945 to assist in post-war reconversion and this was so successful that it has now become an annual event and a tradition in the industry.

BRITISH INDUSTRIAL CONSULTING LINK WITH COMMON MARKET

TO develop trading opportunities with the European Common Market and to encourage closer exchange of industrial and management "know-how" between Britain and Europe, Production-Engineering Ltd. (industrial and management consultants) recently founded a new organization in Paris.

This organization, Production-Engineering Société Anonyme (3, Square de l'Opera, Paris IXeme—phone Opéra 65-54), is a member of the PE Group of companies—one of the "Big Four" in British industrial consultancy. Production-Engineering Société Anonyme has already carried out several assignments in France, including an important one for the French shipbuilding industry. Prominent among its specialized services is electronic data processing. President-Directeur of P.E.S.A. is Mr. R. A. Crompton-Roberts, and other directors include Mr. D. L. Nicolson, managing director of Production-Engineering Ltd., Mr. A. F. Frodsham, assistant managing director of P.E. Ltd., and M. Lucian-Jean Levy, a distinguished French marine and railway engineer.

NEW EXHIBITION AT CRYSTAL PALACE

AFTER an interval of 25 years, the Crystal Palace is again to be the site of a major international exhibition, when the Construction Equipment Exhibition will be launched in June 1961 on a 25-acre site by arrangement with the London County Council. A new company has been formed to sponsor the project — Construction Equipment Exhibitions Ltd. — the shares of which will be held by the Federation of Manufacturers of Construction Equipment, the National Federation of Manufacturers of Construction Equipment, the National Federation of Building Trade Employers, the Federation of Civil Engineering Contractors and Industrial and Trade Fairs Ltd. The managing director will be Mr. V. G. Sherren.

The products to be shown at the exhibition will vary from the smallest hand and mechanical power tools to the largest earth-moving machinery. The organization of the exhibition will be carried out by Industrial and Trade Fairs Ltd., Drury House, Russell Street, Drury Lane, London, W.C.2. to whom all enquiries should be addressed.

STEWART WALES AND SOMERVILLE EXPAND

STEWART Wales and Sommerville Ltd., of Rutherglen, who introduced "Coseal," a liquid plastic roof and wall dressing, and Galvaloy, a rust-proofing liquid metal alloy, a year ago, are planning a factory at Rutherglen or East Kilbride. The products are meantime being manufactured for the firm, but on expiry of the present agreements it is intended to establish their own factory and start production. Mr. Arthur S. Wales, director, began research into the problems of effective sealing of structures by plastics and called in research chemists to assist. On the basis of this work, the two new products were established with considerable success. The company now have regional offices in Birmingham, Aberdeen and London and is planning the development of the European Free Trade Area from Scandinavia.

A NEW northern sales and service centre for the Griffin and George group was officially opened at Ledson Road, Wythenshawe, Manchester 23. recently.

CHANGES OF ADDRESS

FLEXIBLE Drives (Gilmans) Ltd., makers of boiler scaling, tube cleaning and other equipment, including flexible drives, have transferred their registered office and works from Carlton House, High Street, Smethwick 41. to Skatoskalo Works, Millers Road, Warwick (tel. Warwick 448-9).

THE sales office of Laporte Titanium Ltd. is now located at New Bond Street House, 1-5 New Bond Street, London, W.1, instead of at Hanover House. The new accommodation also houses the advertising and publicity instead of at Fetter Lane as previously. The new telephone number is Hyde Park 0631-7.

OBITUARY

Clements. The death recently occurred, as a result of a motor accident, of Mr. H. C. Clements, who had been associated with W. Canning and Co. Ltd., Great Hampton Street, Birmingham 18, engineering division, for 40 years and was a member of the board of directors until prolonged ill-health lead to his resignation last November.

CASTROL DOUBLE EMPLOYEES PENSIONS

PENSIONS at twice the present rate are to be given to all male manual employees of the Castrol Group in the United Kingdom who are members or who later become members, of one of the Group's pensions schemes. A skilled workman with thirty years' service will get £200 a year for life at 65 instead of £100; a foreman with similar service £300 instead of £150. The new scheme, like its predecessor, is paid for entirely by the Group and workers make no contributions themselves. Several hundred men at the Group's thirteen installations and factories in the United Kingdom are affected by the pension schemes which are considered to be the most comprehensive for manual workers in the country. Castrol have decided that all their employees in the United Kingdom, manual or otherwise, shall participate in the Government's new graduated pension scheme.

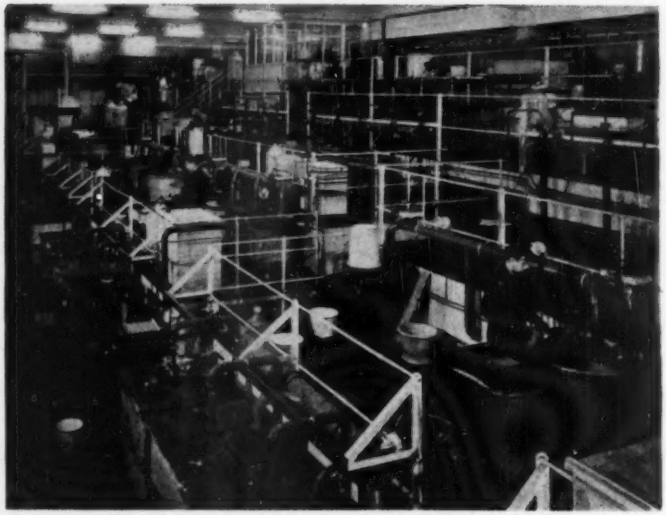
Joseph Townsend Close Down

AS a result of internal reorganization, Joseph Townsend Ltd., an associated company of Borax Consolidated Ltd., have ceased to trade, and a branch office of Borax Consolidated Ltd. has, therefore, been established at 176, Bath Street, Glasgow, C.2. (telephone No. Douglas 3338), with Mrs. H. McLaren as manager.

Local stocks continue to be held in Scotland and local orders should be addressed to the new Glasgow office.

ASHBURTON CHEMICALS EXPAND

THE new laboratory and administration buildings of the Ashburton Chemical Works Ltd. at Trafford Park, Manchester, were opened recently by the President of the Board of Trade, the Rt. Hon. Reginald Maudling, M.P., and mark the completion of a stage whereby the laboratories, drawing and administration offices and welfare facilities, hitherto scattered over a 20-acre site of the works, have been concentrated in a single set of buildings. The Ashburton Chemical Works Ltd. is one of the Geigy group of companies concerned in the manufacture and distribution of chemicals, dyestuffs, pigments and plastics, many of which, including metal chelates, wetting, brightening and corrosion inhibiting additives, are in common use in the metal industries.



PLATINUM REFINERY AT ROYSTON

A SYSTEM of unplasticised P.V.C. fume extraction pipework, fabricated and installed by Extrudex Ltd. at the Royston platinum refinery of Johnson Matthey and Co. Ltd., has now been working satisfactorily for three years. The ductwork extracts from a succession of refining pans highly corrosive fumes which are carried away through P.V.C. eliminator boxes and scrubbing towers, before release to the atmosphere. Previously, the only possible material for such an installation would have been stone-ware or glass.

NEW COMPANIES

"Ltd" is understood, also "Private Co." Figures = Capital, Names = Directors, all unless otherwise indicated.

Pipe Coating Services. September 8. £100. To carry on the bus. of contractors for the application of coatings for the protection of metals against corrosion, rust, etc. Directors not named. Solicitors, Theodore Goddard and Co., London, W.C.2.

J. W. Pepper, Midgeley's Yard, Halifax Road, Keighley. September 8. £2,000. To carry on bus. of car sprayers etc. John W. Pepper, Venetia M. Wilson.

A.B.A. Plating, 9a Woodthorpe Road, Ashford. September 15. £1,000. Desmond C. Hibbs, David G. Brodie.

Carlton Polishing and Plating, 42 Brass Street, Birmingham. September 22. £100. Jas. T. Parker, Maurice J. Parker, Joseph Underhill.

Henry Hemingway, Emscote Street, South, Halifax. September 27. £100. To take over bus. of a brassfounder and brass finisher carried on at Halifax. Norman Kendall, Violet Kendall.

D. R. Newman, 45 Newhall Street Birmingham. September 30. £1,000. To carry on the bus. of metal polishers and finishers, plating engineers, etc. Dennis R. Newman, Mrs. D. E. Newman.

Skinners (Electro-platers), 16, Langley Street, Luton. September 30. £1,000. Bruce Skinner, Shirley R. Thornton.

Technical Hardfacing, Hulme Locks, Egerton Street, Manchester, 15. September 30. To carry on the bus. of deposition of heat, abrasion and corrosion resistant alloys, annealers and welders. Denis E. Farley and Mrs. Olive Farley.

General Steel Wares, Regina House, 259 Marylebone Road, N.W.1. October 7. 69,062 shares of 100 dollars (5% cum. prefd.) and 1,000,000 common shares. Regd. in Canada in October 1927 to carry on bus. of manufacturers and dealers in metals, brass finishers, etc. Dirs. not named.

From the Register compiled by Jordan & Sons Ltd 16 Chancery Lane, London, W.C.2.

INTERNATIONAL CONGRESS ON METALLIC CORROSION

PLANS for the congress to be held at the Imperial College of Science and Technology, Kensington, London, S.W.7, between April 10 and 15, 1961, have reached an advanced stage and it is now possible to give an outline of the provisional programme.

The congress will be opened on Monday afternoon, April 10, by the president, Sir Harry Melville, K.C.B., D.Sc., F.R.I.C., F.R.S., and will be followed by the first scientific session for the presentation and discussion of papers. The following four days—Tuesday, April 11 to Friday, April 15—will each start with a plenary lecture to be given respectively by the following eminent authorities in the field of metallic corrosion—Professor Y. M. Kolotyrkin (U.S.S.R.), Professor P. Lacombe (France), Professor H. H. Uhlig (U.S.A.), and Dr. U. R. Evans (U.K.).

Scientific sessions will follow the plenary lectures until lunch time on each day and will also be held on Wednesday and Friday afternoons. A variety of visits to laboratories and industrial organizations is being arranged on Tuesday and Thursday afternoons instead of scientific sessions.

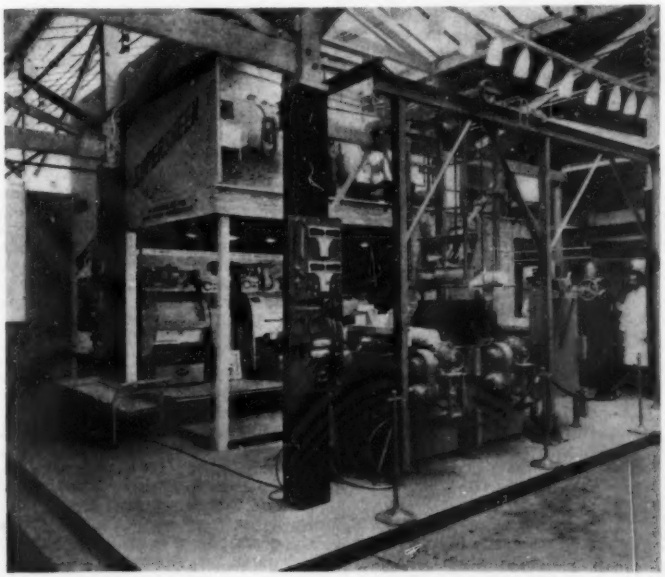
The response to the Scientific Committee's invitation to submit papers has been such that it has been necessary to close the list of acceptances in order that adequate time may be allotted for presentation and discussion of papers at the congress; there will be a total of about 100 papers, all of a very high standard, emanating from eighteen countries, including many by the most outstanding workers in the field of corrosion science. The papers will be grouped under the following headings—High Temperature Oxidation; Atmospheric Corrosion; Underground Corrosion; Inhibitors; Electrochemical, Thermodynamic and Kinetic Studies; Laboratory Corrosion Testing and Experimental Methods; Protection by Non-Metallic Coatings or by Chemical Treatment; Cathodic and Electrolytic Protection; Stress and Intergranular Corrosion; Corrosion Fatigue; Corrosion in Boilers and Heat Exchangers; Corrosion in the Atomic Energy Field; Industrial and Service Experience.

In collaboration with the organizers of the congress, the Science Museum (which is close to the lecture theatres) is arranging a Corrosion Exhibition mainly of historic interest which should prove specially attractive to delegates from overseas. Social events arranged for the evenings will include a Government reception, other receptions and a banquet. An attractive programme for the ladies is being arranged by a Ladies' Committee under the chairmanship of Lady Melville.

The following have accepted vice-presidencies for the Congress; Professor G. Chaudron (France), Professor W. Feitknecht (Switzerland), Dr. H. P. Godard (Canada), Dr. F. L. Laque (U.S.A.), Professor R. Piontelli (Italy), Dr. M. Pourbaix (Belgium), Dr. F. N. Speller (U.S.A.), Professor N. D. Tomashov (U.S.S.R.) Dr. W. H. J. Vernon, O.B.E. (U.K.), and Professor K. Wagner (Germany).

SUBMERGED BARRELLING TECHNIQUE

THE submerged barrelling process, conceived by the Almco Supersheen organization, is shown in the accompanying illustration in operation at the recently held Factory Equipment Exhibition. By this process, multi-cycle finishing is made a continuous operation by retaining the components and finishing media in a perforated barrel and rotating this while submerged in a succession of appropriate solutions contained in open tanks. Mechanical aids, arranged to suspend the barrel over a tank for drainage and transfer it for rotation in the succeeding tank, enable the process to be completed with the minimum of labour and delay. Three horizontal closed barrel-finishing machines are shown inside the stand.



REDUCTION IN PRICE OF ARALDITE RESINS

FOLLOWING upon the price reductions recently announced for "Araldite" resins for surface coatings, lower prices have also come into effect for other forms of Araldite epoxy resins. At the same time, a new nomenclature system has been introduced to simplify identification of the various resins and adhesives of the "Araldite" range. Full details are available from the manufacturers of "Araldite"—CIBA (A.R.L.) Ltd., Duxford, Cambridge.

CHANGE OF ADDRESS

THE new address of the Union Oxide and Chemical Co. Ltd. is 6 Eldon Street, London, E.C.2. Telephone No. Bishopsgate 6741, telegraphic address Unichem, Stock, London.

Trade and Technical Publications

The European Federation of Purchasing, which consists of the professional organizations of buyers in industrial and public undertakings in Belgium, France, Germany. Netherlands, Norway, Sweden and the United Kingdom, has just published the proceedings of its Second European Purchasing Conference held in Holland in April, 1960, under the title "Purchasing In Europe."

This 108-page publication is printed in three languages, English, French and German, and contains all the papers given at the Conference in their original language, with summaries in the other languages. These papers include :—

- Common Problems of Buyers in Europe, by Paul Gros. (France)
- The Organization of a Purchasing Department — Selection and Training of Personnel, by J. Murray Grammer (U.K.)
- The Relations between the Purchasing Department and other Departments, by Hanns Rump (Germany).
- The Purchasing Officer's Relations Outside his own Department, by J. Rieu (France).
- How we started Value Analysis, by H. Lundgren (Sweden).
- Terms of Purchasing, by T. Beil (Norway).
- Attributes of the Buyer, by M. Landenne (Belgium).
- The Position of the Purchasing Department in the Budget of an Enterprise, by E. Reichmuth (Switzerland).
- Centralised or Decentralised Purchasing, by A. F. Baeder (Austria.)

Copies may be obtained at 5s. each from European Federation of Purchasing, Wardrobe Court, 146a, Queen Victoria Street, London, E.C.4. (Tel. No. CITy 3841).

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The Department of Scientific and Industrial Research have published a 112-page report of the Water Pollution Research Board for 1959 dealing with the processes for the treatment of polluting liquids, industrial waste waters, sewage, effects of pollution on fish, the effect of water weeds on oxygen balance in fresh water streams and a survey of the Thames Estuary. The publication is available from H.M.S.O. price 7s. 0d. (by post 7s. 5d.) or through any bookseller.

Gas-Carburizing furnaces using Incoloy DS, nickel-chromium-iron alloy, for the retort containing the carbon rich atmosphere is the subject of an illustrated article in the edition of "Wiggin Nickel Alloys," No. 57.

Further articles include, the use of Nimonic 90 heat-resisting alloy in the "hot-zone" of a high temperature extensometer built for the R.A.E. ; mechanical seals for pumps and other equipment used in the chemical industry in Monel corrosion-resistant alloys ; details of research work which has gone into improved alloys for spark plug electrodes and descriptions of many types of solenoid valves using Nilo 48 controlled-expansion alloy for the magnetic components.

The publication is free on request from Henry Wiggin and Co. Ltd., Publicity Department, Thames House, Millbank, London, S.W.1.

* * *

Dust Control Processes Ltd., 161 Clarence Street, Kingston-upon-Thames, have issued a brochure describing a process for preventing the emission of corrosive and greasy black particles and the corrosion of flues and stacks in oil-fired installations. The system is to inject into the flue gases a controlled concentrate of finely divided alkaline hygroscope precipitate which absorbs acid and fine greasy particles into agglomerated particles which are then extracted from the gas stream by centrifugation. Three items of equipment are required, the "Insufflator" for injection of precipitate into the flue, the "Turbulator" to ensure mixing of the powder and gases, and the "Turbocell Dust Collector."

* * *

The latest edition of the Pye Scientific Instrument catalogue describes several important new developments which will interest all those concerned with scientific research or industrial production testing and process control.

Catalogue "N" is distinguished by its orange cover and it supersedes all previous editions which should now be destroyed.

Copies can be obtained from W. G. Pye and Co. Ltd., Granta Works, P.O. Box 60, Cambridge, England.

A new technical bulletin outlining the physical and chemical properties as well as the suggested uses for dodecenyl succinic anhydride is offered by Allied Chemical International.

The chemical compound contributes unusual properties to epoxy resins when used as a curing agent and to rubber when employed as a compounding material. It is easily handled and blends readily with both liquid and solids.

It is claimed to yield hard but more flexible castings with epoxy resins and, when handled with care, it does not irritate the skin. The cured products have excellent electrical properties and flexural strength.

The compound can also be used as an intermediate for plasticizers, rust-inhibiting compounds, leather treating agents, and in the manufacture of paints, pharmaceuticals and various plastics.

Copies of the 29-page booklet, I-8R, are available from Allied Chemical International, 40 Rector Street, New York 6, N.Y., U.S.A.

* * *

Imperial Chemical Industries Ltd., Imperial Chemical House, Millbank, London, S.W.1., have issued data sheets giving the properties of the first three of their "Silcoset" silicone rubbers, 100, 101 and 102, which can be cured at room temperature by the addition of one of two catalyst supplied with the product and the curing time varied to suit the needs of the user. The rubbers are suitable for sealing, patching, caulking and potting applications, encapsulation of delicate electronic parts and moulds for casting resins and for low cost tooling.

* * *

Work on methods of improving the corrosion-resistance of nickel-chromium electrodeposits (particularly in connexion with the plating of car components) continues to form the subject matter of a large proportion of the technical literature given in abstract form in the electrodeposition section of a recent issue of "The Nickel Bulletin" published by The Mond Nickel Co. Ltd., Thames House, Millbank, London, S.W.1.

* * *

Croda Ltd., Cowick Hall, Snaith, Goole, Yorkshire, have issued a Technical Data Sheet, "Gelanol, Bright Bar Protective," describing the properties of Gelanol, which is a combination of lanolin derivatives, gelling agents, corrosion inhibitor and mineral lubricating oils, best applied by a brush or soft clean cloth, for the protection of machines and working parts, bright steel rod, etc.

TECHNICAL BOOKSHELF

Electropolishing, Anodising and Electrolytic Pickling of Metals, by N. P. Fedot'eo and S. Ya. Grilikhes, translated by A. Behr, 1959. Robert Draper Ltd. 285 pp. Illustrated. 58s.

Few metal finishing technologists have a working knowledge of Russian and acquaintance with Russian technical literature has been confined to abstracts of Russian originals which until recently were sadly inadequate. It has become increasingly evident that in this field, as in others, there are useful ideas to be gained from closer acquaintance with their contributions to technology. The publishers are to be congratulated on being the first to embark on publication of a full-scale translation of a Russian book on metal finishing.

To our ears the title sounds clumsy, but at least it states accurately the contents of the book. The unity of the text depends on the fact that the processes described are all electrolytic, and most of them anodic. In fact the first two chapters fulfil the function of providing the theoretical framework underlying the processes described and in respect of anodic processes attempt to offer a theoretical model for them. This model is largely a summary of work carried out by Grilikhes for his Candidates' Dissertation. One suspects that the book originated as a literature review prior to the commencement of this research.

It is difficult to judge whether this book gives a fair indication of Russian practice. If one opinion is correct, there are definite indications that in some respects the Russians are making more use of electropolishing of steel, particularly carbon steels, than is the case in this country. Certainly, one of the particular attractions of the book is the amount of practical detail it contains. Having no reason to maintain, for commercial reasons, secrecy on composition and processing "know-how," there is no difficulty in the U.S.S.R. about publishing this information. One cannot fail to note that there seems to be considerable effort devoted to investigating the "know-how" of such processes.

Although much of the information on the Battelle phosphoric-sulphuric-chromic electrolyte will not be new to those acquainted with the art, this book provides this information conveniently under one cover and well set out.

Of course the book also has its limitations. The processes described are mainly ones filched from the capitalist West and placed in the service of communism without acknowledgement to their originators. There are few references to relevant work outside Russia (particularly American), although it is probable that a Russian would similarly criticise any British book. Some of the views expressed on mechanism of processes could well be subject to a little comradely criticism by our academic colleagues.

The sections dealing with electropolishing of copper, nickel, aluminium, zinc and other metals gives briefer but adequate coverage of the important processes for these metals. The sections dealing with practical aspects and effects on properties are particularly useful. About a quarter of the book is concerned with aluminium. The review of the basic mechanism of anodizing lacks acquaintance with more recent significant contributions from outside of Russia. The chapter on Industrial Anodising is nevertheless quite a sound summary of relevant practice.

There are some minor mis-translations and errors, although these are very few for a work of such complexity. Of course the price is sufficiently high to discourage many technologists acquiring a copy out of their own pockets. They should not have undue difficulty in persuading their company that this is a book which should undoubtedly be in the library.

A. W. BRACE.

Electroplated Coatings of Cadmium and Zinc on Iron and Steel. British Standard 1706; 1960. British Standards Institution, Sales Branch, 2 Park Street, London, W.1. 20 pp. 5s.

This revised publication specifies the purity, appearance, thickness and adhesion of coatings, the corrosion resistance of passivated coatings, and the appearance, covering and adhesion of a chromate film. Classification is in all cases by thickness.

Full test procedures for establishing the quality of the coatings are given in a series of appendices. They deal with: local and average thickness; adhesion; humidity (in relation to passivated coatings); and the presence and adherence of chromate film.

A sampling method is specified—and there are recommendations for sampling small articles which would normally be barrel plated. Other recommendations concern the heat treatment of plated articles of steel with a nominal tensile strength of 65 tons and over.

TECHNICAL *and* INDUSTRIAL APPOINTMENTS

Nash and Thompson Ltd., Hook Rise South, Tolworth, Surrey, have made the following changes in their personnel—Mr. R. G. Smith as contracts manager, Mr. A. L. Leo as sales engineer for the Midlands and Northern England, Mr. D. H. Yates as sales office manager and Mr. A. Ward as chief inspector.

* * *

Mr. J. Foulds has been appointed technical sales representative for **Kelvin and Hughes** products in North and North Eastern England, covering Northumberland, Durham, Cumberland, Westmorland, North Riding of Yorkshire and Barrow-in-Furness. He was formerly service engineer and then contracts engineer at the Hillington factory of Kelvin and Hughes. His address is 110, Claremont Road, Whitley Bay, Northumberland.

* * *

Mr. Norman J. Travis has been appointed deputy managing director of **Borax Consolidated Ltd.**

* * *

Mr. Carl R. Smith has joined **Hanson-Van Winkle-Munning Co.** as sales representative in the Kentucky-Tennessee area with headquarters at Louisville in place of Mr. Joseph P. Muscarella, jr. who has been transferred to the company's Philadelphia territory.

* * *

Mr. D. F. Kershaw has been appointed general manager of **Wolf Electric Tools Ltd.,** Canadian Branch, at 93 Advance Road, Toronto 18, Ontario.

* * *

Mr. A. E. Richards has been appointed managing director of **Universal Matthey Products Ltd.,** the joint subsidiary company of Universal Oil Products Company and Johnson, Matthey and Co. Ltd., formed in 1953 to meet the needs of the petroleum and petrochemical industries for catalysts.

MEETINGS OF THE MONTH

November 16

Institution of Mechanical Engineers. "Teaching of Metallurgy to Engineers" by Professor J. G. Ball, at 1 Birdcage Walk, Westminster, S.W.1, 6.0 p.m.

November 17

Institute of Metals (Sheffield Local Section). "Metal and the Architect," by A. Daykin, B.A., A.R.I.B.A., in the Applied Science Building of the University, St.Georges Square, Sheffield, at 7.30 p.m.

November 22

Institute of Metal Finishing (South-West Branch). Chairman's address, "American Developments in Plating Zinc Alloy Die Castings," by L. A. J. Lodder, at the Royal Hotel, Cardiff. 7.30 p.m.

November 25

Institute of Metal Finishing (Sheffield and N.E. Branch). "Architectural Colour Anodizing," by A. W. Brace, at the Grand Hotel, Sheffield. 7.0 p.m.

December 1

Institute of Metal Finishing (North-West Branch). "Electroless Nickel," by G. Holliday, at the Engineers' Club, Albert Square, Manchester. 7.30 p.m.

Society of Chemical Industry (London Branch). "The Influence of Water Movement on Corrosion," A "Ferrous Materials," by G. Butler, B "Non-ferrous Metals," by N. V. Nowlan, at the Empire Restaurant, Olympia. 2.0 p.m. and 3.45 p.m.

Institution of Plant Engineers (Sheffield and District Branch). Annual Dinner and Dance at the Grand Hotel, Sheffield. 7.30 p.m.

December 3

Institution of Plant Engineers (South Wales Branch). Branch Annual Dinner and Dance at the Seabank Hotel, Porthcawl, Glam. 7.0 p.m.

December 5

Institute of Metal Finishing. Annual General Meeting, 2.30 p.m. Hothersall Memorial Lecture by Professor J. W. Cuthbertson, 3.30 p.m., Annual Dinner 7.30 p.m. at the Cafe Royal, Regent Street, London, W.1.

December 6

Institution of Chemical Engineers (London Branch). "Study on electro-precipitator performance in relation to particle size distribution, level of collection efficiency and power input," by D. O. Heinrich, at the Geological Society, Burlington House, London, W.1. 5.30 p.m.

December 6

Institute of Metal Finishing (Midland Branch). "Corrosion Resistance of Articles Plated with Duplex Nickel," by H. C. Castell, at the James Watt Memorial Institute, Great Charles Street, Birmingham, 3. 6.30 p.m.

December 7

Institution of Plant Engineers (Birmingham Branch). "Paint Spraying," at the Hotel Leofric, Coventry. 6.30 p.m.

December 8

Institute of Metals (Birmingham Local Section). "Beryllium" by J. Williams, at the College of Technology, Gosta Green, Birmingham, 6.30 p.m.

December 9

Institution of Plant Engineers (North East Branch). Annual Supper at the Crown Hotel, Newcastle-upon-Tyne.

Institute of Metal Finishing (Midlands Branch). Christmas "Depositors Do" at the Grill Room, White Horse Hotel, Congreve Street, Birmingham. Rendezvous at 6.0 p.m. Dinner 7.30 p.m.

Sheffield Metallurgical Association. Annual Dinner Dance, at the Royal Victoria Hotel, Sheffield.

December 12

Institute of Metal Finishing (London Branch). "Unusual Anodizing Methods and their Practical Significance," by J. M. Kape, at the Northampton College of Technology, St. John Street, London, E.C.1. 6.15 p.m.

December 14

Institute of Metal Finishing (Organic Finishing Group). "Problems in Factory Painting," by D. W. Marshall, at the British Institute of Management, Management House, 80 Fetter Lane, London, E.C.4. 6.30 p.m.

Institute of Metal Finishing (Sheffield and N.E. Branch). "Confidence in Plating" by G. E. Sandlands, at the Grand Hotel, Sheffield. 7.0 p.m.

December 20

Institute of Metal Finishing (South-West Branch.) "Methods of Preparation for Plating"—(b) Polishing, at the Assize Courts Hotel, Bristol. 7.30 p.m.

LECTURES IN METAL FINISHING AND METALLURGY

THE Division of Metal Science of the Borough Polytechnic, Borough Road, London, S.E.1, are holding two special courses in the Spring Term of the 1960/1961 session. Each of these consist of six lectures; the first course, "Recent Developments in Non-Electrolytic Metal Finishing" will be given on successive Thursdays commencing at 7.0 p.m. commencing January 12 and the second will be given on successive Tuesdays commencing February 7, 1961, dealing with "Metallurgy of Rarer Metals." The lectures on metal finishing will be "Catalyst Reduction of Nickel from Aqueous Solutions," by A. Mc. L. Aitken Esq., "Galvanising," by Morgan Davies, Esq., "Conversion Coatings other than Phosphating," by W. T. Lee, Esq., "Phosphating," by H. A. Holden, Esq., "Metal Spraying," by D. E. J. Cunningham, Esq., and "Hard Surfacing," by G. R. Bell, Esq.; those on metallurgy will consist of "Purification of Metals," by Dr. I. Jenkins, "Beryllium," by L. R. Williams, Esq., "Zirconium," by T. R. Brown, Esq., "Tantulum and Niobium," by R. Titterington, Esq., "Tungsten and Molybdenum," by R. Titterington, Esq., and "High Temperature Metals and Alloys," by Dr. R. Smith.

BRITON GAINS AMERICAN PLATING AWARD

MR. A. W. Wallbank, B.Sc., F.R.I.C., managing director of Ionic Plating Co. Ltd., Grove Street, Birmingham 18, the metal finishing division of the G.K.N. group of companies, received the Carl E. Heussner A.E.S. Gold Medal Award, the Society's highest paper award, for his paper entitled "Barrel Plating with Special Consideration to Protection of Thread Diameters," at the American Electroplaters' Convention at Los Angeles, in July.

New Coating Service

(*continued from page* 451)

and wire metal spray guns are used for flame spraying zinc, aluminium and stainless steel as well as for the synthetic coatings. Pipes and ducting can be internally coated by spray or flow coating. Other types of application are by spray, brush and trowel.

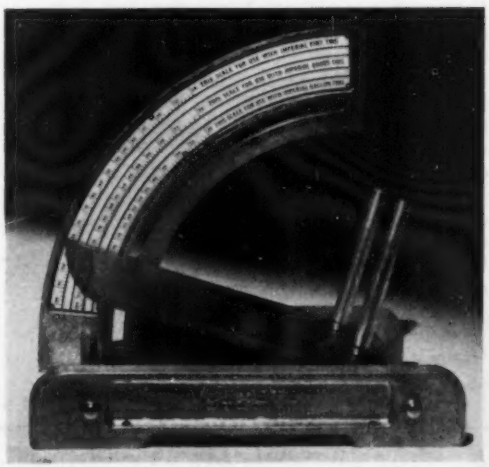
West's Loyne Ltd. is a company recently jointly formed by W.G.I. Ltd. (West's Group of Industries), engineers, of Manchester, and Loyne Ltd., protective coating specialists, of Ashton-under-Lyne.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Colour Mixing Device

THE industrial division of Blundell, Spence and Co. Ltd., have produced a colour mixing device, the Vulmeter, which needs no dipstick, but uses the relation between the angle of tilt and volumetric content to indicate the amount of each ingredient colour, when mixing paints to prescribed formulae. The device, Fig. 1, consists of a tilting platform, secured by a wing nut, and a quadrant scale which indicates at various degrees of tilt, the amount of unthinned paint required to produce ½ pint, 1 pint or ½ gallon in tins of twice those capacities. The method of mixing is to place the tin on to the platform which is tilted until the pointer indicates on the appropriate scale the amount of the first basic colour read from the mixing formula ; a spring clip is then fixed to the tin on the lower side and the paint poured in until it just touches the tip of the clip ; the platform is adjusted and the performance repeated for each basic colour. The paint is then thoroughly stirred and thinners added when the tin is upright to bring the level of the paint up to a special mark on the spring clip. The device is intended exclusively for users of Blundell, Spence and Co's two main transport finishes, Vulflo Self Gloss and One Coat Glossex.

Fig. 1—Colour mixing device

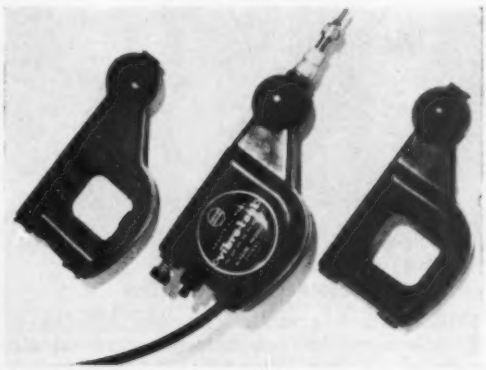


Electrically-Operated Hand Engraver

FIG. 2 shows a multi-purpose electrically-operated hand engraver produced by Burgess Products Ltd., of Sapcote, Leicestershire, which is claimed to be capable of marking operations that are outside the scope of electric-arc etching machines. It will engrave ferrous metals of all hardnesses and will permanently mark all other kinds of hard surfaces such as brass, plastics, glass, ceramics and hardboard, as well as cutting heavy gauge card templates.

The tool is supplied complete with a carbide-tipped engraving point or with a kit of 20 interchangeable accessories. The casing is moulded by the Mechanical Rubber Co. Ltd., using a " Cellobond " rubber reinforcing resin which confers increased hardness, improved electrical properties and resistance to oils and greases.

Fig. 2—Hand Engraver



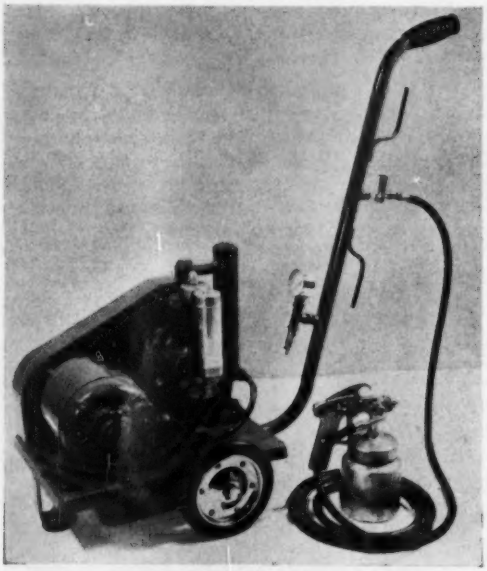
Liquid Nickel Chloride

THE Hanson-Van Winkle-Munning Co. of Church Street, Matawan, New Jersey, U.S.A., have produced a new instant liquid nickel chloride which is claimed to have advantages over dry nickel chloride in that it eliminates dissolving problems, ease in handling, and better storage. The material weighs only 11.75 lb. per gallon and is packed in 50-gallon steel drums with a special corrosion-resistant liner. The solution requires no stirring or pre-mixing.

Portable Compressor

FIG. 3 shows a small compressor, the PE3AD, marketed by Atlas Copco (Great Britain), Ltd., of Hemel Hempstead, Herts. The compressor unit and motor are mounted on a base plate fixed to a two-wheel, solid-tyred chassis complete with front support, making it easily manoeuvrable. The long steering handle has a rubber grip and serves as a pulsation damper and air receiver ; it can be detached for transport or storage. Piston displacement is 3 cu. ft. per min. and it will deliver air at pressures up to 100 lb. per sq. in. It has been designed for use with the Atlas Copco Ecco spray guns, models L22 and D2, and the recommended pressure for paint spraying is 45 lb. per sq. in.

Fig. 3—Portable compressor

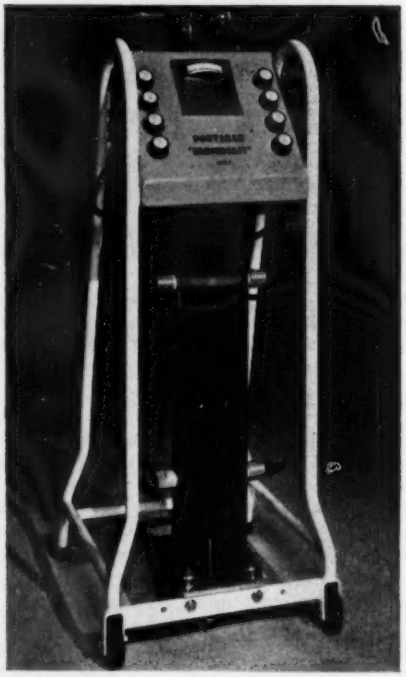


Portable Water Purifier

THE Mark 6 portable " Deminrolit," Fig. 4, is a mixed bed ion exchanger, designed and produced by The Permutit Co. Ltd., Permutit House, Gunnersbury Avenue, London, W.4. It can convert up to 12 gallons hourly of clean cold water into demineralized water having a conductivity of less than 1.0 reciprocal megohm per centimetre and conforming to the " Purified Water " standard of the British Pharmacopoeia, 1958. The ion exchange materials used are " Zeo-Karb 225 " and " De-Acidite FF " manufactured at the chemical production division of Permutit in South Wales.

The unit is designed for regeneration on the spot and is fitted with a conductivity tester which continuously monitors treated water quality. It is a free standing unit of non-corrodible construction and is suitable for workshop as well as laboratory conditions ; no expensive plumbing is required as it is connected by flexible hose.

Fig. 4—Portable water purifier



New Time Indicator

A SERIES of compact, electro-chemical, elapsed time indicators have been introduced by Industrial Instruments Ltd., of 9 Paved Court, Richmond, Surrey, for the recording of the total operation time of electrical equipment.

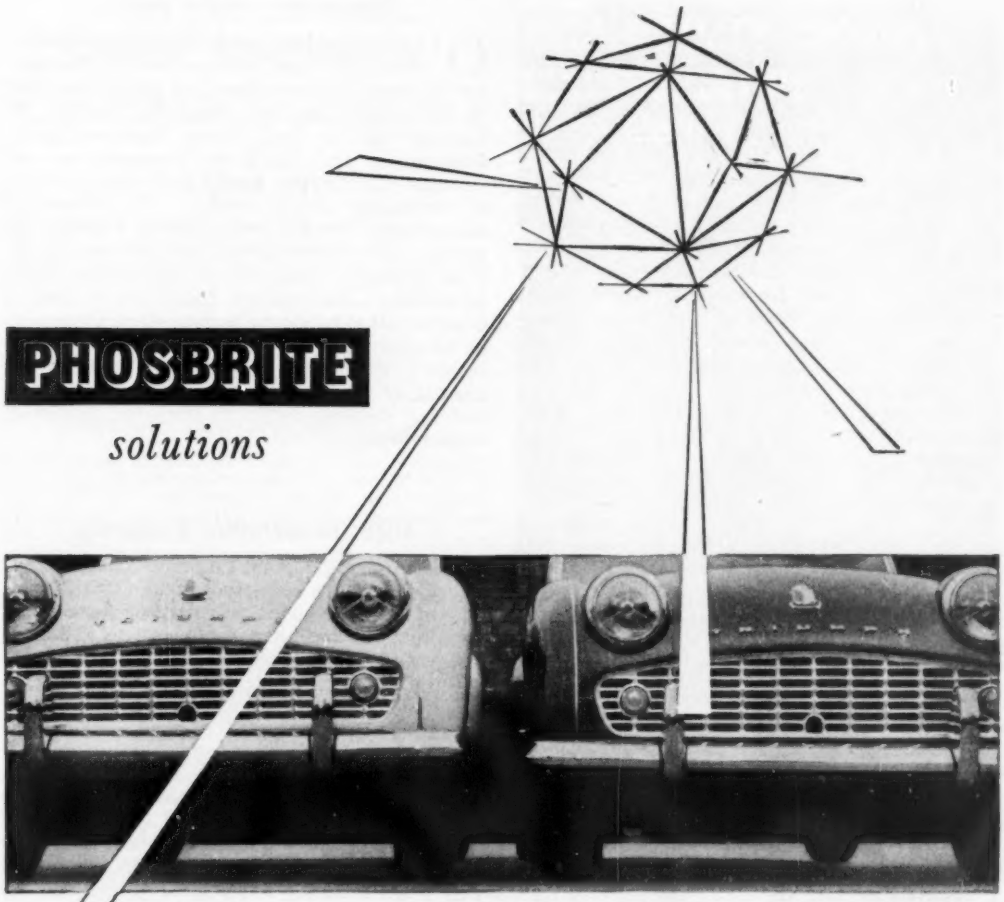
These new indicators, known as the Selachron range, have been designed in forms suitable for either a.c. or d.c. operation and in sizes for use with voltages of from 6 volts to 300 volts, thus obviating the need for any extra switches or relays and allowing them to be wired to the terminals of the equipment being timed. The indicators use no moving parts and consist of cartridges which contain small, replaceable electro-chemical cells, embodying an anode, cathode and electrolyte. The anode is consumed as current passes through the cell, the length diminishing in proportion to the accumulated hours of operation, this being shown by a calibrated scale alongside the anode.

The length of each indicator is 2⅜ in., the diameter being 1 in. The weight is less than 2 oz.

(*Continued in page* 462)

PHOSBRITE

solutions



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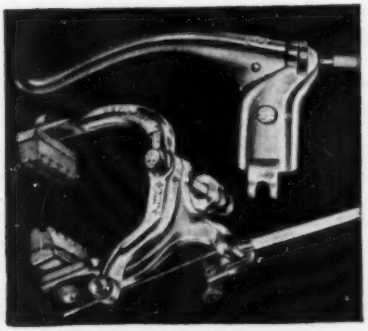

Whether it is car trim (like the Triumph T.R. 3 grille above) or cycle brakes (like the G.B. Cycle Components Ltd. product on the left) you will find that chemical polishing with Phosbrite solutions saves time and money.

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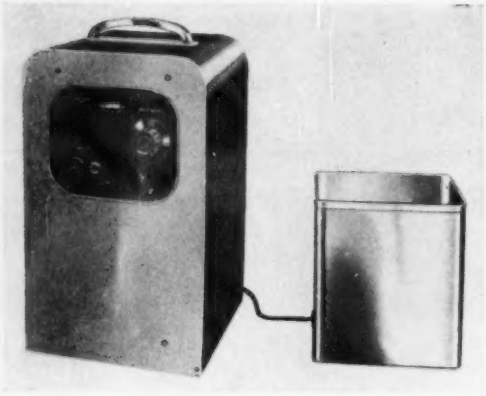
SBW/681

Bench Type Ultrasonic Cleaner

FIG. 5, shows the bench-mounted ultrasonic cleaning unit, type L364, and cleaning tank type L368, produced by Mullard Equipment Ltd., for whom Kerry's (Ultrasonics) Ltd., of Warton Road, Stratford, London. E.15, are the sole U.K. agents. The generator gives an output of 500 watts and the operating frequency is 40 kc/s ; the stainless steel tank has a cleaning area of 8 in. by 6 in. by 10 in., a capacity of 1½ gallons (6 litres) and incorporates a transducer assembly, 6 in. by 4 in. by 2¾ in. of stainless steel construction. The generator can be supplied with separate transducers so that the latter may be mounted in existing tanks or used to meet particular cleaning requirements. A solvent filtration unit, type LPU60/Z, for the removal of solids down to particle size of approximately one micron is available as an extra, as also is a vapour still, type BVS10, having a tank 8 in. by 8 in. by 9 in., for use with trichlorethylene or perchlorethylene as a component drying or solvent recovery unit.

Fig. 5—Bench type cleaner



Hard Water Additive

AEROSTYLE Ltd. of Sunbeam Road, North Acton, London, N.W.10, have developed a hard water additive, which is claimed to prevent the build-up of lime deposits mixed with paint on water-wash booth flow sheets which is a frequent occurrence, particularly in hard water areas. The effect of this deposit is that it dulls the reflective surface of the flow sheets, thereby lessening the light in the booths, and while it can be removed with phosphoric acid and abrasives, this action results in a further dulling of the surface. The new additive maintains the finish of the flow sheets and is introduced in the proportion of approximately 6 to 8 lbs. per 100 gallons, according to hardness and acidity.

Oxygen-free copper anodes

OXYGEN-free high conductivity-copper anodes, which have been widely advertised throughout the American press, have now become available in this country and are obtainable through W. Canning and Co. Ltd., Great Hampton Street, Birmingham 18. There are a number of advantages these copper anodes have over extruded or electrolytic copper anodes ; the absence of oxide means there is more copper available for plating ; the uniform crystal structure enables the anode to dissolve uniformly without under-cutting or graining ; the uniform dissolution at solution level as well as below the surface allows the anodes to be used until they are almost completely dissolved ; absence of copper oxide reduces the amount of sludge formed ; uniform dissolution and low sludging results in improved quality of copper deposits.

High Temperature Respirator

THE American Optical Co., Southbridge, Mass., U.S.A., have developed an industrial respirator in which moulded polyurethane foam forms an integral part, enabling plant personnel to breathe safely and comfortably in temperatures up to 300 deg. F., such as are found in kilns, furnaces and ovens. The device is basically a heat-exchanger consisting of 65 layers of regular aluminium screening contained in a semi-rigid foam shell of polyurethane moulded in the shape of a cylinder, 3 in. outside diameter, which insulates them from high ambient temperatures. The screens are locked into place by a perforated outer plate and the entire cartridge is 3 in. in length and weighs only 6 oz., including a face piece of soft moulded rubber ; the respirator may be attached to a special aluminized asbestos hood, leaving only the cartridge outside. If the cartridge becomes heated from prolonged use, it is easily replaced by a fresh cartridge while the hot unit is allowed to cool. In operation, the respirator cools air to a comfortable temperature before delivering it to the user ; as the wearer inhales, hot air is forced through the layers of metal screen, which absorb and store much of the heat ; exhalation through the opposite direction strips the heat from the screens and cools the cartridge for the next cycle. Once equilibrium conditions are established, the temperature of the inhaled air remains constant at approximately 100 deg. F. Breathing difficulties encountered in freezers, cold rooms, etc., can also be alleviated by the respirator, in which cases the heat exchange is reversed—cold incoming air being made more comfortable by the warm respirator screens.

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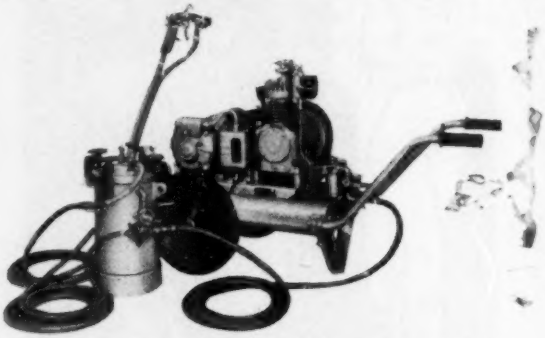

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